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DEVELOPING A STATE WATER PLAN

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1966

COOPERATIVE INVESTIGATIONS REPORT NO. 4

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DEVELOPING A STATE WATER PLAN

Ground-Water Conditions in Utah, Spring of 1966

by

J. W. HOOD AND OTHERS

United States Geological Survey

Prepared by the United States Geological Survey

in cooperation with the State of Utah

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CONTENTS

	<i>Page</i>
Introduction	10
Utah's ground-water reservoirs	12
Summary of conditions in 1965	14
Major areas of ground-water development	17
Cache Valley by L. R. Herbert	17
East Shore area, Weber Delta and Bountiful districts by R. G. Butler	20
Jordan Valley by R. W. Mower	25
Tooele Valley by A. H. Handy	31
Northern Utah Valley by R. M. Cordova	34
Southern Utah and Goshen Valleys by R. M. Cordova	40
Cedar Valley by R. D. Feltis	44
Juab Valley by L. J. Bjorklund	47
Sevier Desert by R. W. Mower	52
Sanpete Valley by G. B. Robinson, Jr.	58
Central Sevier Valley by L. J. Bjorklund	62
Upper Sevier Valleys by G. B. Robinson, Jr.	65
Pavant Valley by R. W. Mower	68
Beaver Valley by G. W. Sandberg	75
Cedar City Valley by G. W. Sandberg	78
Parowan Valley by G. W. Sandberg	81
Escalante Valley, Milford district, by G. W. Sandberg	84
Escalante Valley, Beryl-Enterprise district, by G. W. Sandberg	87
Other areas by R. G. Butler	92
References	95

ILLUSTRATIONS

<i>Figure</i>	<i>Page</i>
1. Map of Utah showing areas of known or potential ground-water development	13
2. Map of Cache Valley showing change of water levels, March 1965 to March 1966	18
3. Hydrograph showing relation of water levels in well (A-12-1) 29bdd-1 to cumulative departure from the 1931-60 normal annual precipitation at Logan Utah State University	19
4. Map of the East Shore area, Weber Delta and Bountiful districts, showing change of water levels from March 1965 to March 1966	21
5. Hydrographs showing relation of water levels in wells near Bountiful, Layton, Clearfield, Ogden, and Plain City to cumulative departure from the normal annual precipitation at Farmington and average annual precipitation at Ogden	22
6. Map of the East Shore area, Weber Delta and Bountiful districts, showing changes of water levels, March 1953 to March 1966	24
7. Graph showing estimated population of Salt Lake County, water withdrawn through wells, and annual precipitation at Midvale for the period 1932-65	27
8. Map of the Jordan Valley showing change of water levels from February 1965 to February 1966	28
9. Map of the Jordan Valley showing change of water levels from February to September 1965	29
10. Hydrographs showing relation of water levels in selected wells in the Jordan Valley to cumulative departure from the 1931-60 normal annual precipitation at Silver Lake Brighton	30
11. Map of Tooele Valley showing change of water levels in artesian aquifers, March 1965 to March 1966	32

<i>Figure</i>	<i>Page</i>
12. Hydrographs showing relation of water levels in selected wells in Tooele Valley to cumulative departure from the 1931-60 normal annual precipitation at Tooele	33
13. Hydrographs showing relation of water levels in wells (D-5-1) 20aba-1 and (D-5-1)20aba-2 to cumulative departure from the 1931-60 normal annual precipitation at Utah Lake Lehi	35
14. Map of northern Utah Valley showing change of water levels in the water-table aquifer in the Lake Bonneville Group, March 1965 to March 1966	36
15. Map of northern Utah Valley showing change of water levels in the shallow aquifer in rocks of Pleistocene age, March 1965 to March 1966	37
16. Map of northern Utah Valley showing change of water levels in the deep aquifer in rocks of Pleistocene age, March 1965 to March 1966	38
17. Map of northern Utah Valley showing change of water levels in the aquifer in rocks of Tertiary age, March 1965 to March 1966	39
18. Map of southern Utah and Goshen Valleys showing change of water levels, March 1965 to March 1966	42
19. Hydrograph showing relation of water levels in well (D-8-2) 4cba-2 near Lake Shore to cumulative departure from the 1931-60 normal annual precipitation at Payson	43
20. Map of Cedar Valley showing water-level contours, March 1966	45
21. Hydrographs showing relation of water levels in wells in Cedar Valley to cumulative departure from the 1943-63 average annual precipitation at Fairfield.	46
22. Map of Juab Valley showing change of water levels from March 1965 to March 1966	49
23. Hydrographs showing relation of water levels in wells (D-11-1) 9bbb-4 and (C-15-1)12aba-1 to cumulative departure from the 1931-60 normal annual precipitation at Nephi and Levan.....	50

<i>Figure</i>	<i>Page</i>
24. Graph showing relation of number of pumped irrigation wells to pumpage for irrigation in the Sevier Desert, 1950-65	54
25. Map of part of the Sevier Desert showing change of water levels in the lower artesian aquifer, March 1965 to March 1966	55
26. Map of part of the Sevier Desert showing change of water levels in the upper artesian aquifer, March 1965 to March 1966	56
27. Hydrographs showing relation of water levels in selected wells in the Sevier Desert to cumulative departure from the 1931-60 normal annual precipitation at Oak City	57
28. Map of Sanpete Valley showing change of water levels, March 1965 to March 1966	60
29. Hydrographs showing relation of water levels in three wells in the Sanpete Valley to cumulative departure from the 1931-60 normal annual precipitation at Manti	61
30. Map of the central Sevier Valley showing changes of water levels, March 1965 to March 1966 and March-April 1957 to March 1966	63
31. Hydrograph showing relation of water levels in well (C-21-1) 27aad-1 near Salina to cumulative departure from the 1931-60 normal annual precipitation at Piute Dam	64
32. Map of the upper Sevier River valleys showing changes of water levels, March 1965 to March 1966 and March 1961 to March 1966	66
33. Hydrograph showing relation of water levels in well (C-34-5) 8adb-2 near Panguitch and average annual discharge of the Sevier River at Hatch to cumulative departure from the 1931-60 normal annual precipitation at Panguitch	67
34. Graph showing relation of number of pumped irrigation wells and total discharge to discharge from flowing wells in Pavant Valley, 1946-65	70

<i>Figure</i>	<i>Page</i>
35. Map of the Pavant Valley showing change of water levels from March 1965 to March 1966	71
36. Map of the Pavant Valley showing decline of water levels from March to August 1965	72
37. Hydrographs showing relation of water levels in selected wells in Pavant Valley to cumulative departure from the 1931-60 normal annual precipitation at Fillmore	73
38. Graphs showing the concentration of dissolved solids in water from six selected wells in Pavant Valley	74
39. Map of Beaver Valley showing change of water levels, March 1965 to March 1966	76
40. Hydrograph showing relation of water levels in well (C-29-7) 21baa-1 and the annual discharge of Beaver River near Beaver to the cumulative departure from the 1931-60 normal annual precipitation at Beaver	77
41. Map of Cedar City Valley showing change of water levels, March 1965 to March 1966	79
42. Hydrograph showing relation of water levels in well (C-35-11) 33aac-1 to cumulative departure from the 1931-60 normal annual precipitation at the Cedar City powerhouse, to the discharge of Coal Creek near Cedar City, and to pumpage for irrigation in Cedar City Valley	80
43. Map of Parowan Valley showing change of water levels, March 1965 to March 1966	82
44. Hydrograph showing relation of water levels in well (C-34-8) 5bca-1 to cumulative departure from the 1931-60 normal annual precipitation at Parowan and to pumpage for irrigation in Parowan Valley	83
45. Map of the Milford district, Escalante Valley, showing change of water levels, March 1965 to March 1966	85

<i>Figure</i>	<i>Page</i>
46. Hydrograph showing relation of water levels in well (C-29-10) 6ddc-2 to cumulative departure from the 1931-60 normal annual precipitation at Milford airport and to pumpage for irrigation in the Milford district, Escalante Valley	86
47. Map of the Beryl-Enterprise district, Escalante Valley, showing change of water levels, March 1965 to March 1966	88
48. Hydrographs showing relation of water levels in wells (C-35-17)25cdd-1 and (C-35-17)25dcd-1 to cumulative departure from the 1931-60 normal annual precipitation at Modena and to pumpage for irrigation in the Beryl-Enterprise district, Escalante Valley	89
49. Map of the Beryl-Enterprise district, Escalante Valley, showing water-level contours, October 1964 and October 1965	90
50. Map of the Beryl-Enterprise district, Escalante Valley, showing water-level contours, March 1966	91
51. Hydrographs showing relation of water levels in wells in selected areas in Utah to cumulative departure from the average annual precipitation at sites in or near those areas	93

TABLES

<i>Table</i>	<i>Page</i>
1. Areas of known or potential ground-water development in Utah	12
2. Well construction and withdrawal of water from wells in 1965 in major areas of ground-water development in Utah	15
3. Summary of estimated well discharge in the Jordan Valley in 1965	25
4. Discharge from wells (estimated) and number of wells in Pavant Valley, 1946-65	68

INTRODUCTION

This report is the third in a series of annual reports that describe ground-water conditions in Utah. Reports in the series are prepared cooperatively by the U.S. Geological Survey and the Utah Water and Power Board and are designed to provide data for interested parties, such as legislators, administrators, and planners, to keep abreast of changing ground-water conditions.

This report, like the first two (Arnow and others, 1964, 1965) contains information on well construction, ground-water withdrawals, water-level changes, and related changes in precipitation or streamflow. It also contains supplementary data that are related to ground-water use in some individual areas. In reports of this series, the inclusion of such supplementary data as graphs showing chemical quality of water and maps showing water-table slope is intended only for those years or areas where applicable data are available and are important to a discussion of changing ground-water conditions.

The report includes individual discussions of the most important areas of ground-water withdrawal in the State for the calendar year 1965. Water-level fluctuations, however, are described for the period spring 1965 through spring 1966. Many of the data used in the report were collected by the Geological Survey in cooperation with the Utah State Engineer.

The following reports dealing with ground water in Utah were released by the U.S. Geological Survey during 1965:

Ground-water conditions in Utah, spring of 1965, by Ted Arnow and others: Utah Water and Power Board Coop. Invest. Rept. 3.

Ground-water conditions and storage in the central Sevier Valley, Utah, by R. A. Young and C. H. Carpenter: U.S. Geol. Survey Water-Supply Paper 1787.

Ground-water resources of Pavant Valley, Utah, by R. W. Mower, U.S. Geol. Survey Water-Supply Paper 1794.

Ground-water conditions and geologic reconnaissance of the upper Sevier River Basin, Utah, by C. H. Carpenter, G. B. Robinson, Jr., and L. J. Bjorklund: U.S. Geol. Survey Water-Supply Paper 1836.

Ground water in northern Utah Valley, Utah: A progress report for the period 1948-63, by R. M. Cordova and Seymour Subliczky: Utah State Engineer Tech. Pub. 11.

Reevaluation of the ground-water resources of Tooele Valley, Utah, by J. S. Gates: Utah State Engineer Tech. Pub. 12.

Ground-water resources of selected basins in southwestern Utah, by G. W. Sandberg: Utah State Engineer Tech. Pub. 13.

Water-resources appraisal of the Snake Valley area, Utah and Nevada, by J. W. Hood and F. E. Rush: Utah State Engineer Tech. Pub. 14 and Nevada Dept. Conserv. and Nat. Resources, Water-Resources Recon. Ser. Rept. 34.

UTAH'S GROUND-WATER RESERVOIRS

Small quantities of ground water can be obtained from wells throughout much of Utah, but large supplies that are of suitable chemical quality for irrigation, public supply, or industrial use, generally can be obtained only in specific areas. These areas of known or potential ground-water development are shown in figure 1 and named in table 1. Only a few wells outside of these areas yield large supplies of water of good chemical quality.

Less than 2 percent of the wells in Utah obtain water from consolidated rocks. The consolidated rocks that yield the most water are lava flows such as basalt, which contains interconnected vesicular openings or fractures; limestone, which contains openings enlarged by solution; and sandstone, which contains interconnected openings between the grains that form the rock. Most of the wells tapping consolidated rocks are in the eastern and southern parts of the State, in areas where water supplies cannot be readily obtained from unconsolidated rocks.

More than 98 percent of the wells in Utah draw water from unconsolidated rocks. These rocks may consist of boulders, gravel, sand, silt, or clay or of a mixture of some or all those size units. Wells obtain the largest yields from the coarser units that are sorted into deposits of equal grain size. Most wells that tap unconsolidated rocks are in large intermountain basins which have been partly filled with debris from the adjacent mountains.

TABLE 1.

*Areas of known or potential ground-water development
in Utah.*

(locations are shown in fig. 1)

Area	Type of water-bearing rocks
1. Curlew Valley	Unconsolidated
2. Park Valley	Do.
3. Grouse Creek valley	Do.
4. Hansel Valley	Do.
5. Blue Creek valley	Unconsolidated
6. Sink Valley	Do.
7. Malad-Lower Bear River valley	Do.
8. Valley east of the Pilot Range	Do.
9a. East Shore area, Weber Delta and Bountiful districts	Do.
9b. East Shore area, Brigham district	Do.
10. Jordan Valley	Do.
11. Cache Valley	Do.
12. Bear Lake valley	Do.
13. Upper Bear River valley	Do.
14. Ogden Valley	Do.
15. Morgan Valley	Do.
16. Park City area	Do.
17. Kamas Valley	Do.
18. Heber Valley	Do.
19. North flank Uinta Mountains	Do.
20. South flank Uinta Mountains	Do.
21. Uinta Basin	Do.
22. Tooele Valley	Do.
23. Skull Valley	Do.
24. Dugway area	Do.
25. Fish Springs Flat	Do.
26. Sevier Desert	Do.
27. Rush Valley	Do.
28. Cedar Valley	Do.
29a. Northern Utah Valley	Do.
29b. Southern Utah Valley	Do.
30. Juab Valley	Do.
31. Sanpete Valley	Do.
32. Central Sevier Valley	Do.
33. Upper Sevier Valleys	Do.
34. Deep Creek valley	Do.
35. White Valley	Do.
36. Snake Valley	Do.
37. Pine Valley	Do.
38. Wah Wah Valley	Do.
39. Escalante Valley, Beryl-Enterprise district	Do.
40. Escalante Valley, Milford district	Do.
41. Beaver Valley	Do.
42. Cedar City Valley	Do.
43. Parowan Valley	Do.
44. Upper Fremont Valley	Do.
45. Lower Fremont Valley	Consolidated
46. Spanish Valley	Unconsolidated
47. Castle Valley (Grand County)	Do.
48. Montezuma Creek area	Consolidated
49. Kanab area	Unconsolidated
50. St. George area	Do.
51. Pavant Valley	Do.
52. Colton area	Consolidated
53. Scipio area	Do.
54. Lisbon Valley	Do.
55. Monticello area	Do.
56. Blanding area	Do.
57. Bluff area	Do.

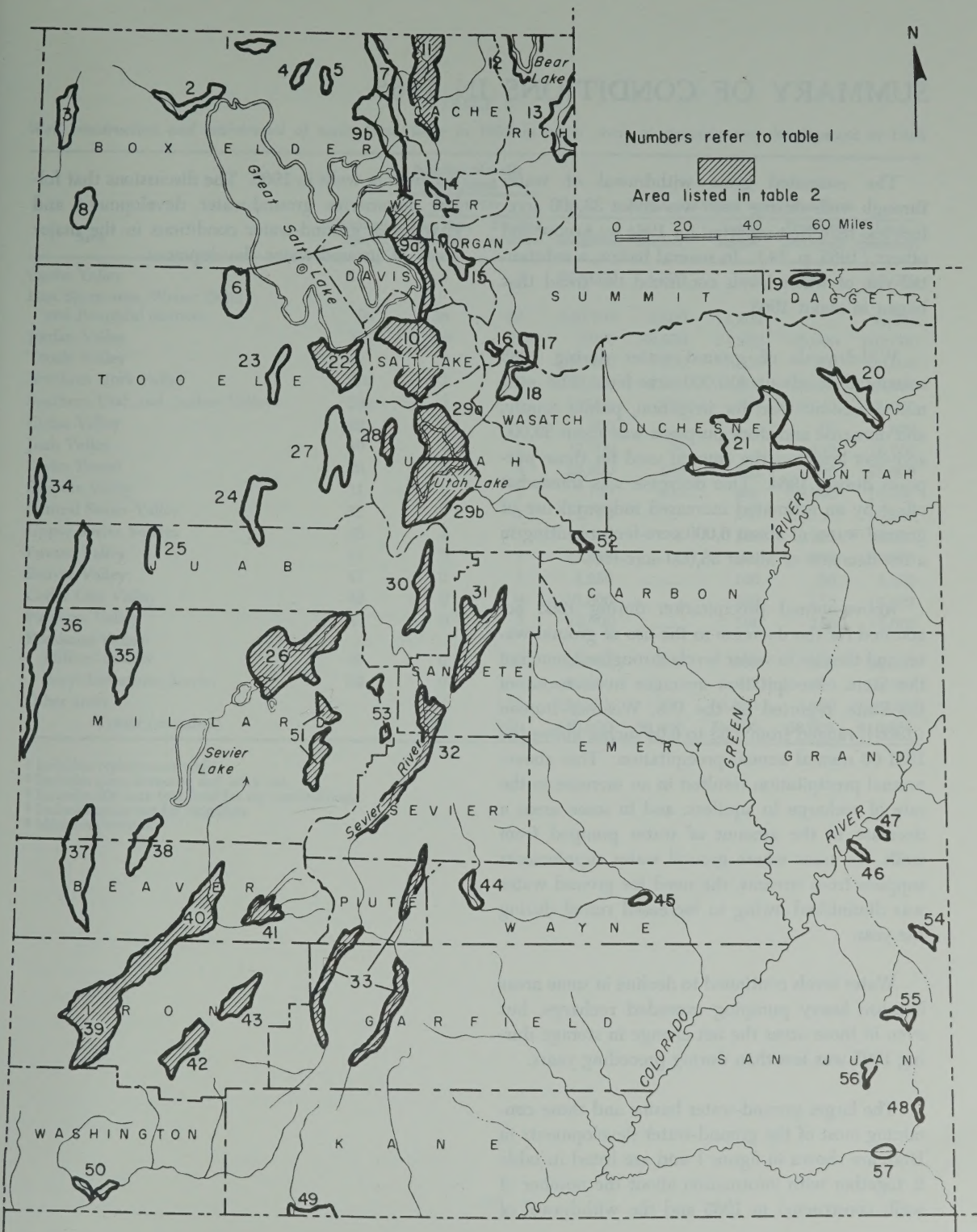


Figure 1.—Map of Utah showing areas of known or potential ground-water development.

SUMMARY OF CONDITIONS IN 1965

The estimated gross withdrawal of water through wells during 1965 was about 33,000 acre-feet less than that reported for 1964 by Arnow and others (1965, p. 14). In several basins, a substantial rise of water levels continued the trend that began in about 1963.

Withdrawals of ground water during 1965 amounted to about 610,000 acre-feet. The estimated amount used for irrigation, public supply, and domestic and stock purposes was about 39,000 acre-feet less than the amount used for those purposes during 1964. This decrease was somewhat offset by an estimated increased industrial use of ground water of about 6,000 acre-feet, resulting in a net decrease of about 33,000 acre-feet.

Above-normal precipitation during 1965 accounted for the decrease in the use of ground water and the rise in water levels throughout much of the State. Precipitation averages in divisions of the State, reported by the U.S. Weather Bureau (1966), ranged from 1.33 to 6.64 inches above the 1931-60 normal annual precipitation. This above-normal precipitation resulted in an increase in the rate of recharge to aquifers, and in some areas a decrease in the amount of water pumped from wells. In areas where ground water supplements supplies from streams, the need for ground water was diminished owing to increased runoff during the year.

Water levels continued to decline in some areas because heavy pumping exceeded recharge, but even in those areas the net change in storage during 1965 was less than during preceding years.

The larger ground-water basins and those containing most of the ground-water developments in Utah are shown in figure 1 and are listed in table 2, together with information about the number of wells constructed in 1965 and the withdrawal of

water from wells in 1965. The discussions that follow summarize ground-water development and changes in ground-water conditions in the major areas of ground-water development.

TABLE 2.

Well construction and withdrawal of water from wells in 1965 in major areas of ground-water development in Utah

Area	Number in figure 1	Number of wells completed ¹		Withdrawal from wells (acre-feet)				
		Diameter		Irrigation	Industry	Public supply	Domestic and stock	Total (rounded)
		Less than 6 inches	6 inches or more					
Cache Valley	11	5	2	² 24,000	3,600	710	.....	28,000
East Shore area, Weber Delta and Bountiful districts	9a	36	23	² 40,700	3,800	14,200	.....	59,000
Jordan Valley	10	19	22	3,000	39,600	24,900	³ 35,000	102,000
Tooele Valley	22	0	9	17,400	400	1,800	100	20,000
Northern Utah Valley	29a	5	5	29,100	6,900	3,800	⁴ 2,500	42,000
Southern Utah and Goshen Valleys	29b	1	4	20,000	570	140	⁴ 10,240	31,000
Cedar Valley	28	0	0	1,800	.....	.....	10	1,800
Juab Valley	30	0	3	17,700	50	.....	140	18,000
Sevier Desert	26	2	9	26,000	100	500	800	27,000
Sanpete Valley	31	5	1	7,700	400	400	⁴ 3,500	12,000
Central Sevier Valley	32	9	3	² 14,700	.....	200	.....	15,000
Upper Sevier Valleys	33	4	3	1,300	3	150	1,120	2,600
Pavant Valley	51	0	7	68,300	.....	150	350	68,800
Beaver Valley	41	0	1	4,250	.....	100	50	4,400
Cedar City Valley	42	0	9	15,600	.....	500	150	16,000
Parowan Valley	43	0	3	15,000	.....	100	150	15,000
Escalante Valley								
Milford district	40	0	2	43,500	100	200	600	44,000
Beryl-Enterprise district	39	0	6	69,200	.....	100	600	70,000
Other areas		14	132	⁵ 24,600	⁵ 350	⁵ 6,600	⁵ 550	⁵ 32,000
Totals (rounded)		100	250	440,000	56,000	55,000	56,000	610,000

¹ Includes replacement wells.² Includes some domestic and stock use.³ Includes 800 acre-feet used for air conditioning.⁴ Includes some use for irrigation.⁵ Minimum amount.

MAJOR AREAS OF GROUND-WATER DEVELOPMENT

CACHE VALLEY

By L. R. Herbert

Cache Valley, as used here, refers to approximately 450 square miles of the valley that is in Utah. Ground water occurs in unconsolidated deposits in the valley, under both water-table and artesian conditions. The aquifers are recharged principally along the sides of the valley, and the ground water moves toward the center of the valley and thence toward a point of discharge from the valley near Cache Junction.

Seven new wells were constructed in Cache Valley during 1965. Five of these wells were less than 6 inches in diameter and two were 6 inches or more in diameter. One well was constructed for public supply, 1 for irrigation, and 5 for domestic, stock, and irrigation.

The discharge from flowing and pumped wells in Cache Valley during 1965 was approximately 28,000 acre-feet of water, broken down as follows:

Irrigation, domestic, and stock use	
(flowing wells)	24,000
Irrigation (pumped wells)	90
Industry (pumped wells)	3,600
Public supply (pumped wells)	710

The total discharge from wells was approximately the same in 1965 as it was in 1964 (Arnow and others, 1965, p. 15). However, the quantity of water pumped for irrigation decreased from about 3,400 acre-feet in 1964 to about 90 acre-feet in 1965. The decrease in pumpage was offset by a corresponding increase in the discharge from flowing wells.

Water levels were higher in March 1966 than in March 1965 in most of the valley. The rise in water levels was caused by above-normal precipi-

tation and a decrease in the amount of water pumped from large irrigation wells. Declines in water levels were recorded in the central and northern part of the valley and in the extreme southern end of the valley. (See fig. 2.)

The long-term relation between fluctuations of water levels and precipitation is shown in figure 3 by the hydrograph of the water level in well (A-12-1)29bdd-1 and the curve showing cumulative departure from normal precipitation at Logan. Precipitation in 1965 was about 0.7 inch more than that in 1964, and it was 3.2 inches above the 30-year normal at Logan. The sharp rise of water level in the well reflects the above-normal precipitation during 1964 and 1965.

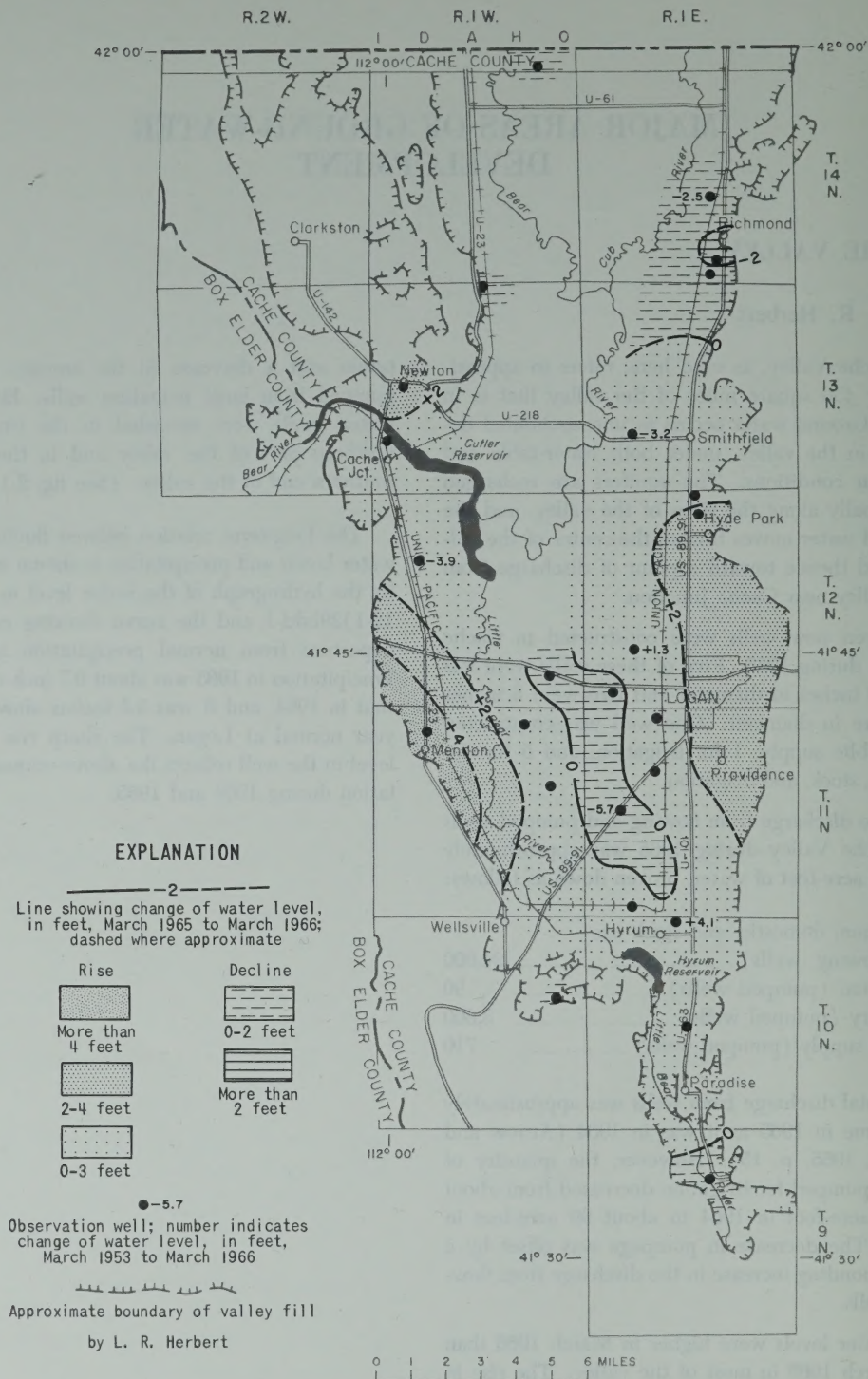


Figure 2.—Map of Cache Valley showing change of water levels, March 1965 to March 1966.

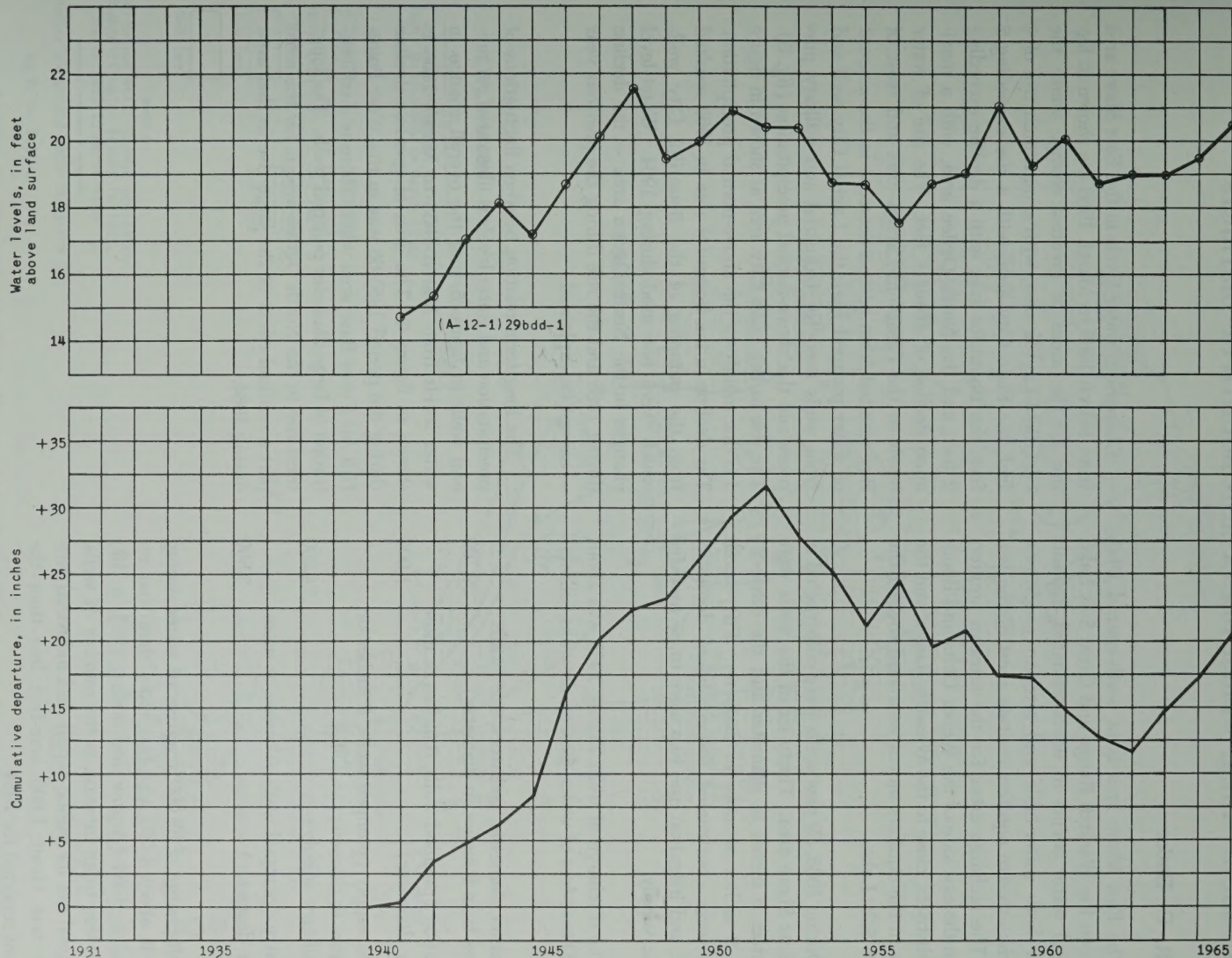


Figure 3.—Hydrograph showing relation of water levels in well (A-12-1)29bdd-1 to cumulative departure from the 1931-60 normal annual precipitation at Logan Utah State University.

EAST SHORE AREA, WEBER DELTA AND BOUNTIFUL DISTRICTS

By R. G. Butler

The East Shore area is in north-central Utah between the Wasatch Range and Great Salt Lake. Ground water occurs in unconsolidated deposits under both water-table and artesian conditions, but the artesian aquifers contain most of the water. The recharge areas for the artesian aquifers are on the east side of the Weber Delta and Bountiful districts, close to the Wasatch Range, and the water in the aquifers moves westward toward the Great Salt Lake.

During 1965, 59 new wells were constructed in the East Shore area. Thirty-six of the wells were less than 6 inches in diameter and the other 23 were 6 inches or more in diameter. Fifty-seven wells were constructed for combined domestic, stock, and irrigation use; two were to be used for public supply.

The discharge of wells during 1965 was about 59,000 acre-feet of water, broken down as follows:

Irrigation, domestic, and stock use (wells less than 6 inches in diameter)	39,700
Irrigation (pumped wells, 6 inches or more in diameter)	1,000
Public supply (pumped wells, 6 inches or more in diameter; includes military supply)	14,200
Industry (pumped wells, 6 inches or more in diameter)	3,800

The discharge of 59,000 acre-feet of water during 1965 is about 4,000 acre-feet more than that reported in 1964 (Arnow and others, 1965, p. 19) and is due to an increase in the number of wells. The total use for public supply and industrial purposes was about 1,600 acre-feet less than the amount reported for 1964.

Changes in water levels in the East Shore area from March 1965 to March 1966 are shown in figure 4. The areas of greatest change were: the Clearfield-Layton area, with a maximum rise of 4 feet; the Plain City area, with a rise exceeding 2 feet; the Bountiful area with a decline exceeding 2 feet; and the North Ogden area, with a maximum decline of about 4 feet. The rise of water levels in the Clearfield-Layton area and west of Roy resulted from both a decrease in the amount of water pumped from the Layton City well and from wells used for industrial and military purposes and the above-normal precipitation (fig. 5). The rise in the Plain City area as shown in figure 4 is due mainly to the above-normal precipitation. The decline in the Bountiful area in 1965 resulted from the pumping of the Bountiful City wells which were not used during 1964. Water-level changes in the North Ogden area — the decline during 1965 and the rise during the previous year — cannot be explained.

The long-term relation between fluctuations of precipitation and water levels is illustrated for several wells in figure 5, and the overall change in water levels from March 1953 to March 1966 is shown in figure 6. The area of greatest decline during the period 1953-66 was in the West Point-Hill Air Force Base area where there is a concentration of large-diameter pumped wells. The long-term rise in the North Ogden area is for the most part a residual effect of the large rise in that area during 1964.

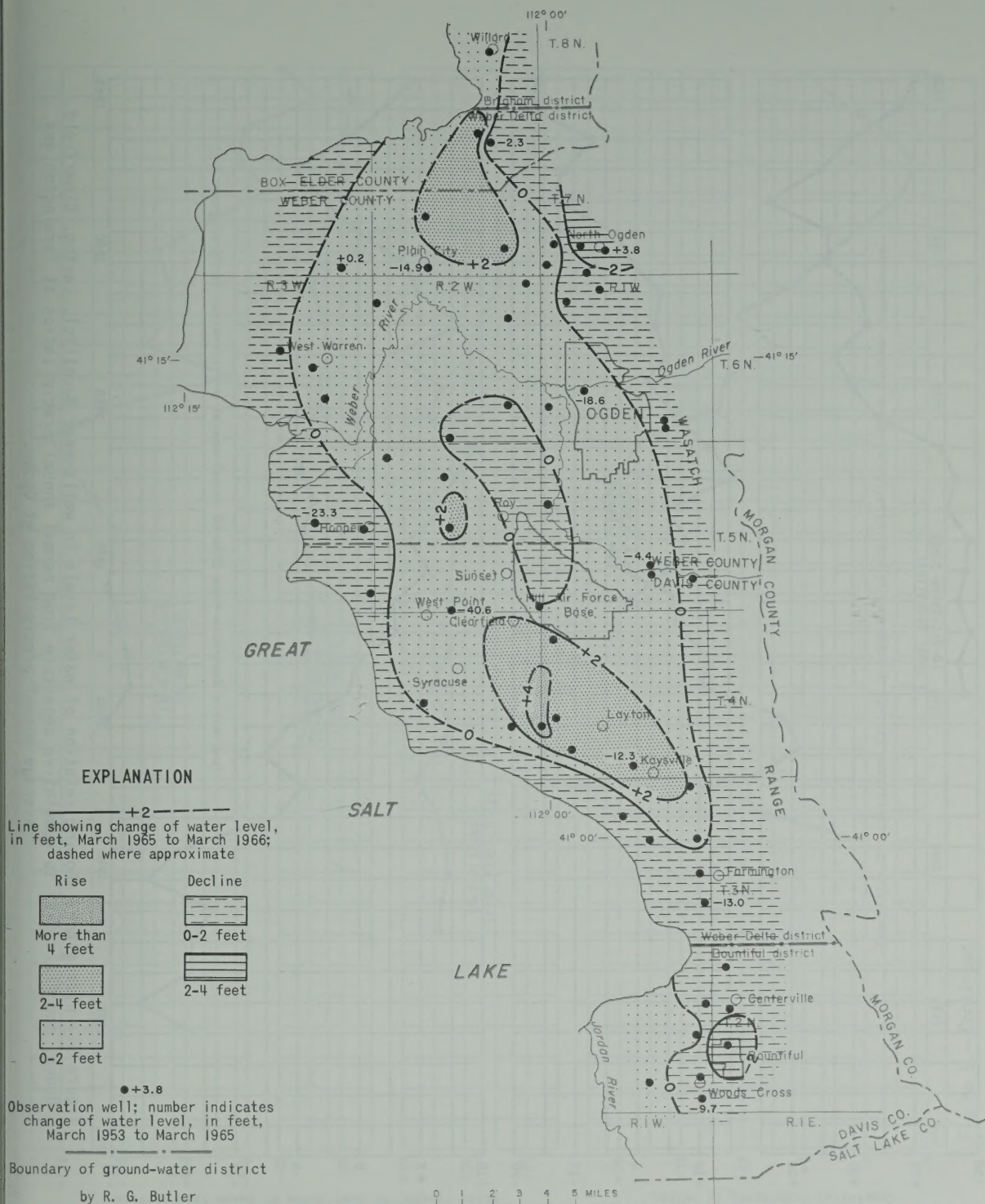


Figure 4.—Map of the East Shore area, Weber Delta and Bountiful districts, showing change of water levels from March 1965 to March 1966.

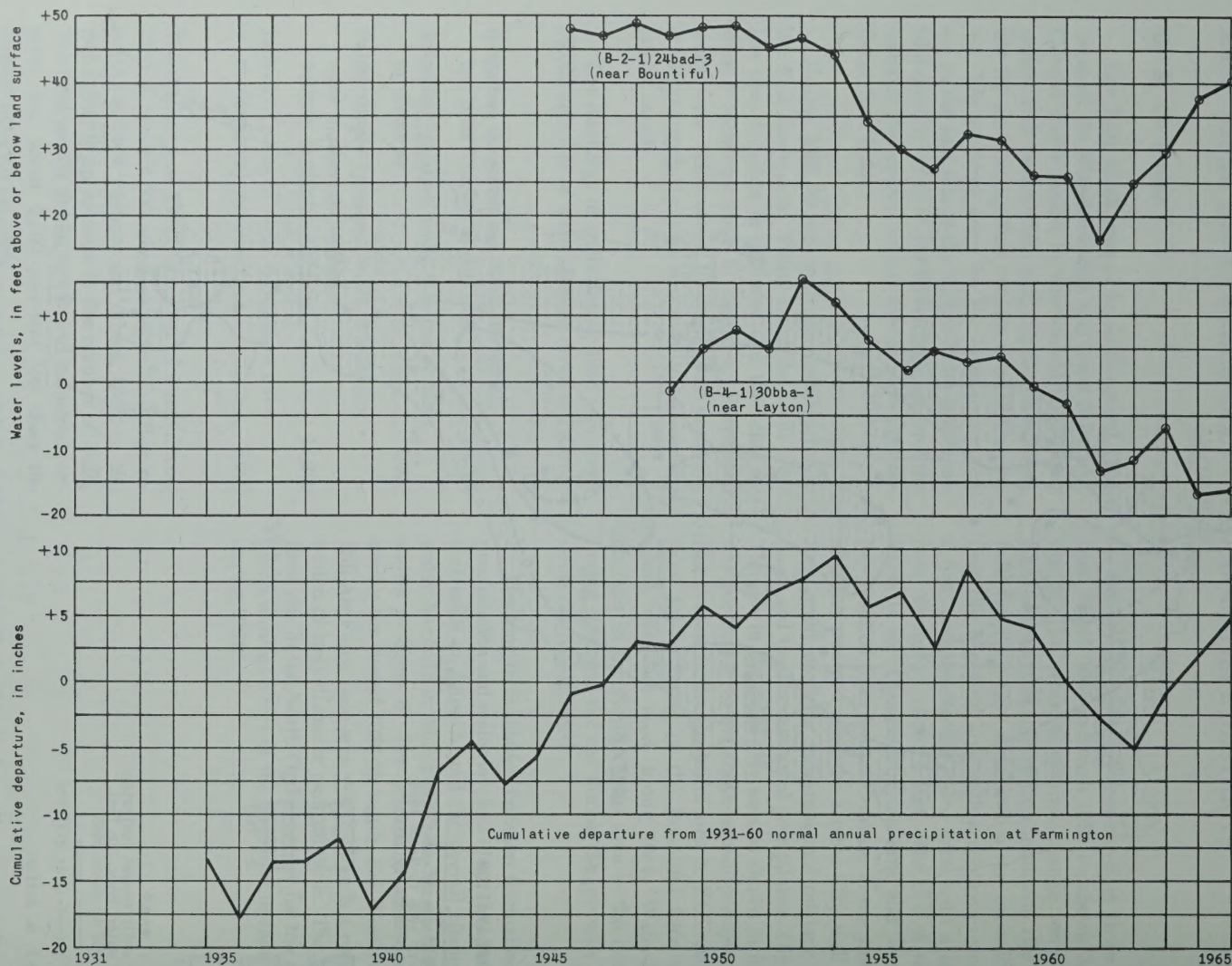


Figure 5.—Hydrographs showing relation of water levels in wells near Bountiful, Layton, Clearfield, Ogden, and Plain City to cumulative departure from normal annual precipitation at Farmington and average annual precipitation at Ogden.

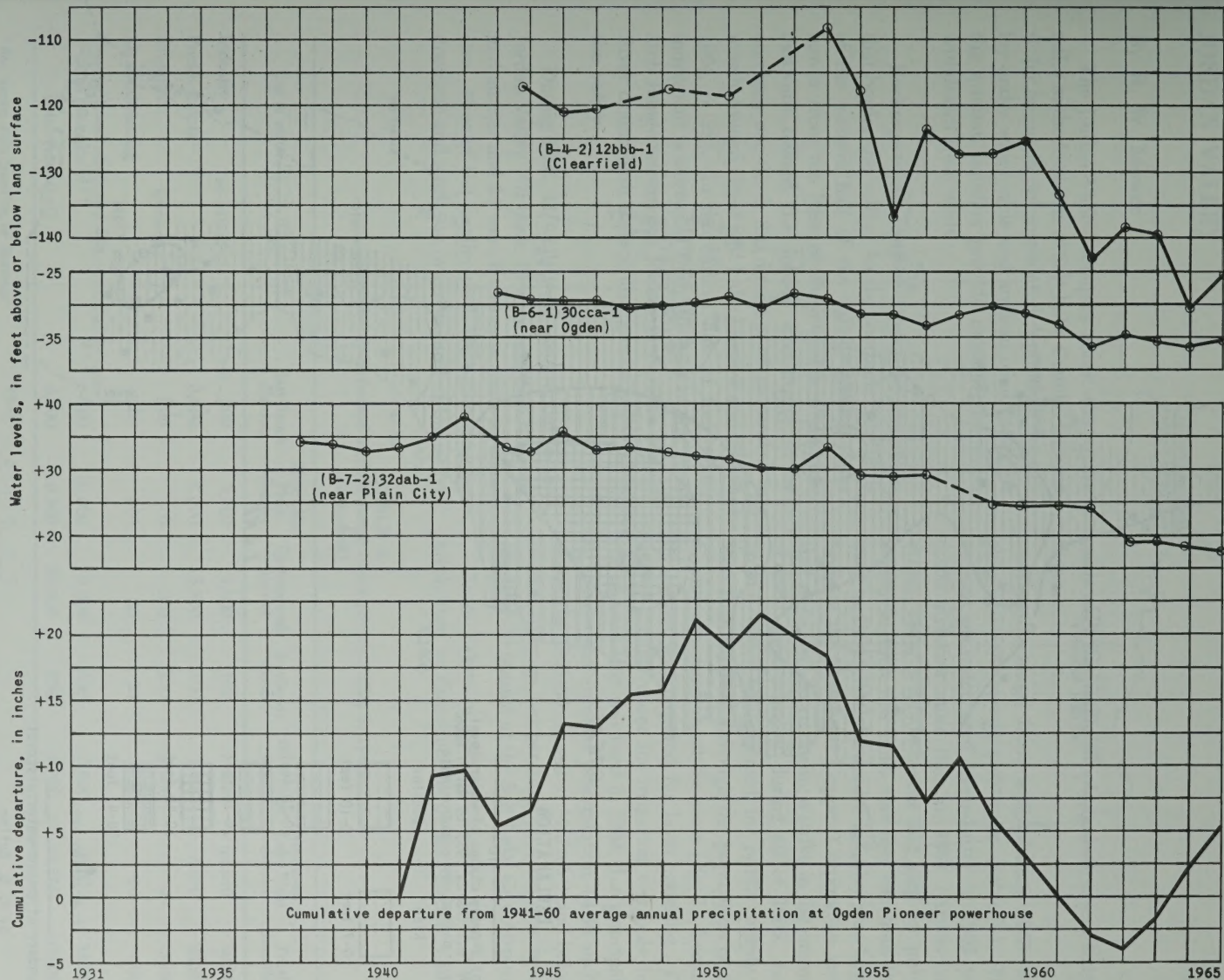


Figure 5.— Continued.

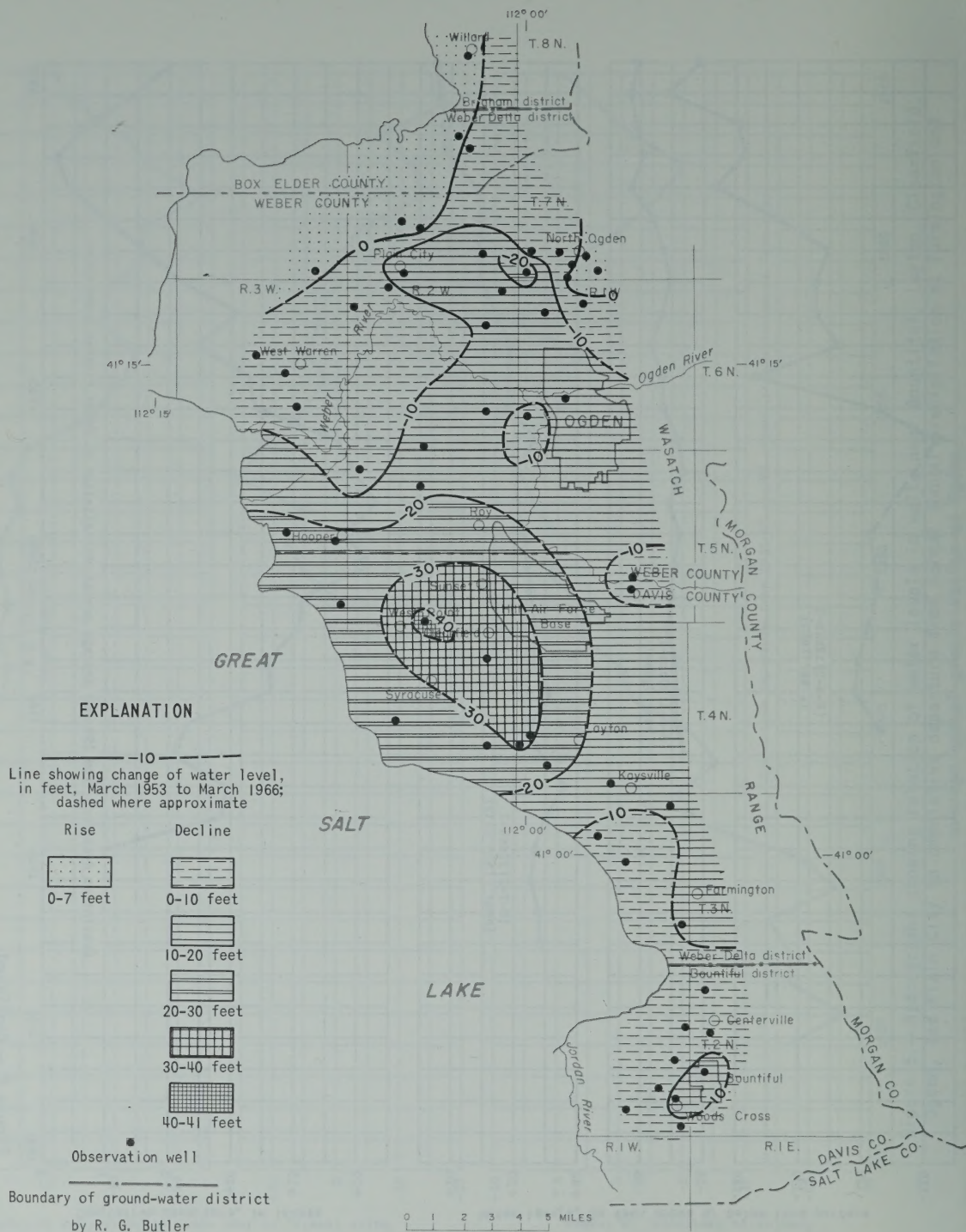


Figure 6.—Map of the East Shore area, Weber Delta and Bountiful districts, showing change of water levels, March 1953 to March 1966.

JORDAN VALLEY

By R. W. Mower

The Jordan Valley occupies about 400 square miles in the lowlands of Salt Lake County. Ground water occurs in unconsolidated deposits in the valley under water-table and artesian conditions, but the artesian aquifers provide most of the water withdrawn from wells.

Recharge to the aquifers is from the mountains that border the valley. In the southern two-thirds of the western half of the valley, ground water moves from the base of the Oquirrh Mountains eastward toward the Jordan River; but in the northern one-third, the direction of movement is mostly toward Great Salt Lake (Arnow and others, 1964, p. 28). In the eastern half of the valley, movement is westward from the base of the Wasatch Range toward the Jordan River. The Jordan River drains both surface and ground water from the valley.

During 1965, 41 wells were constructed in the Jordan Valley. Of these 19 were less than 6 inches in diameter and 22 were 6 inches or more in diameter. Most of the smaller wells were intended for domestic and stock use, whereas most of the larger

wells were for public supply, industry, and irrigation.

The discharge from wells during 1965 was about 102,000 acre-feet of water (table 3). The amount of water used by industry in 1965 was 6,300 acre-feet more than in 1964 (Arnow and others, 1965, p. 24), whereas that used for public supply in 1965 was 7,600 acre-feet less than that used in 1964. Withdrawal by industry was larger because the Kennecott Copper Corporation wells that were shut down during a strike in the summer of 1964 were pumped during all of 1965. Less ground water was pumped for public supply in 1965 than in 1964, although the population of the County remained about the same (fig. 7), because less water was required for lawn watering. The use of ground water for irrigation was only half the amount that was used in 1964, due principally to greater-than-normal precipitation (4.40 inches above the 1931-60 normal at Midvale) and below-normal average temperature (0.4 degrees below the 1931-60 normal at the Salt Lake City Airport).

From February 1965 to February 1966 water levels rose in three-fourths of the Jordan Valley

TABLE 3.
Summary of estimated well discharge in the Jordan Valley in 1965¹
(acre-feet)

Use of water	East Bench district	East Lake Plain district	Cottonwoods district	Southeast district	West Slope district	Northwest Lake Plain district	Total (rounded)
Industry	800	3,900	1,800	100	500	32,500	39,600
Public supply ²	3,600	2,000	15,500	100	1,500	2,200	24,900
Irrigation	100	0	200	200	2,500	0	3,000
Air conditioning	200	600	20	20	0	10	800
Domestic and stock and fish and fur culture	100	10,000	9,000	100	5,000	10,000	34,200
Total (rounded)	4,800	16,500	26,500	500	9,500	44,700	102,000

¹ See figure 8 for location of districts.

² Includes water used by municipalities, public water supply companies, schools, hospitals, and hotels.

and declined in the remainder of the valley (fig. 8). The net average rise in the valley was 2.4 feet. The largest rises were in the southern part of the West Slope district, and the largest declines were near the boundary between the Northwest Lake Plain and West Slope districts. The largest rises were in areas that are usually centers of heavy pumpage but were pumped much less in 1965 than during the previous year. Declines in the central part of the western half of the valley (the only area in which pumpage was appreciably greater during 1965 than it was during 1964) are related to heavy pumping for public supply and industry.

Water levels rose in nearly 60 percent of the valley between the principal pumping season between February and September 1965 (fig. 9). The largest rises were in the area between Herriman and Riverton and along the northeast side of Salt Lake City. The largest seasonal declines were in an area east of the Jordan River, between Salt Lake City and Midvale, where large quantities of water were pumped for public supply. Although this was the area of greatest seasonal decline, there was a net annual rise of more than 5 feet in parts of the area from February 1965 to February 1966. Seasonal rises in most areas were caused by recharge from snowmelt and rainfall during the spring and summer.

The long-term relation between fluctuations of precipitation and water levels is illustrated in figure 10 by the curve showing the cumulative departure from normal precipitation at Silver Lake Brighton and a hydrograph of the water level in a well in each of the ground-water districts. Precipitation during 1965 was 7.35 inches above normal (118 percent of normal), thus, accounting for the continued rise in the precipitation curve (fig. 10). The above-normal precipitation is reflected in a rise of water levels in wells in the East Bench, Cottonwoods, Southeast, and East Lake Plain districts, and in about half of the Northwest Lake Plain and the West Slope districts. In parts of the Northwest

Lake Plain and West Slope districts, water levels declined because pumpage exceeded recharge.

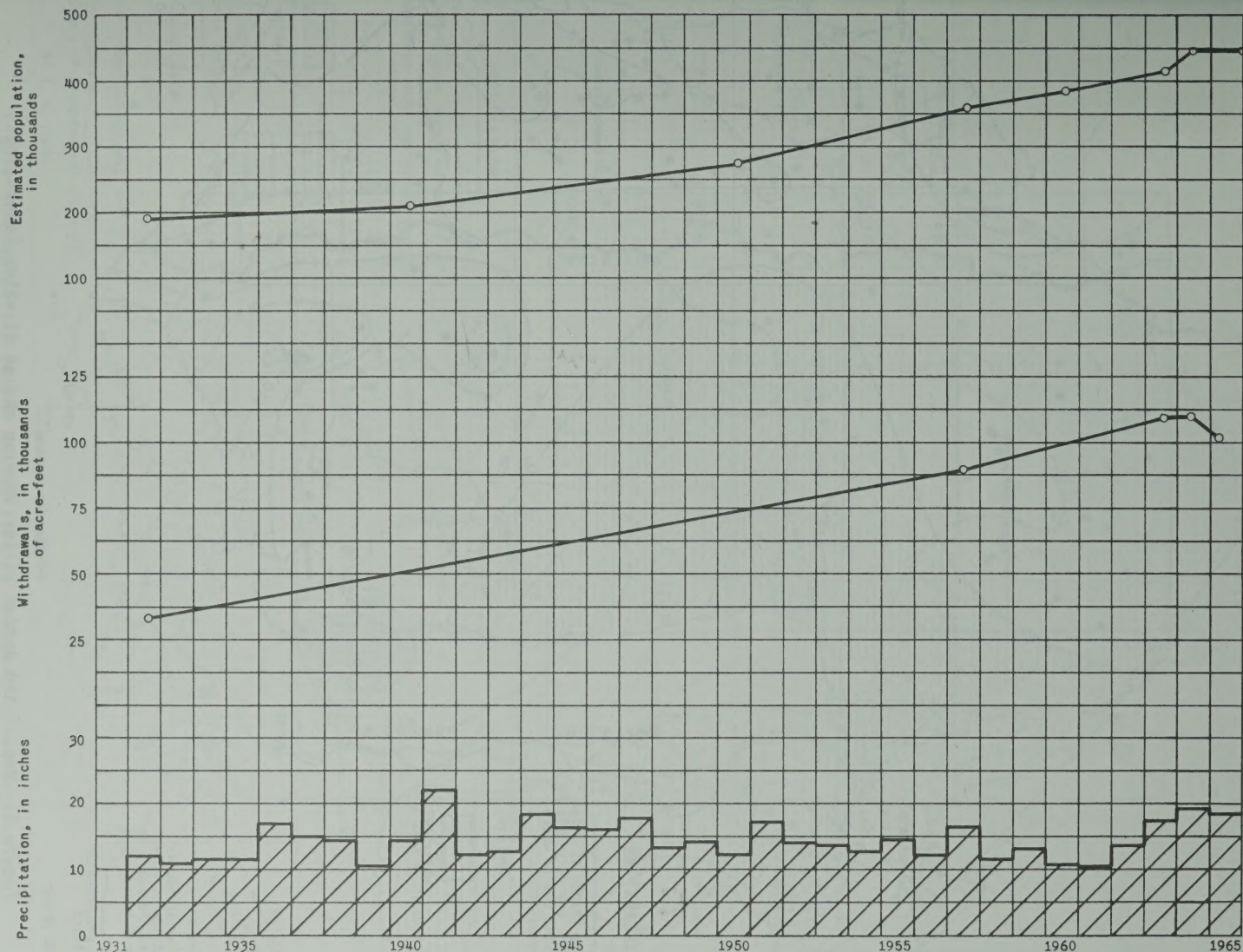


Figure 7.— Graph showing estimated population of Salt Lake County, water withdrawn through wells, and annual precipitation at Midvale for the period 1932-65.

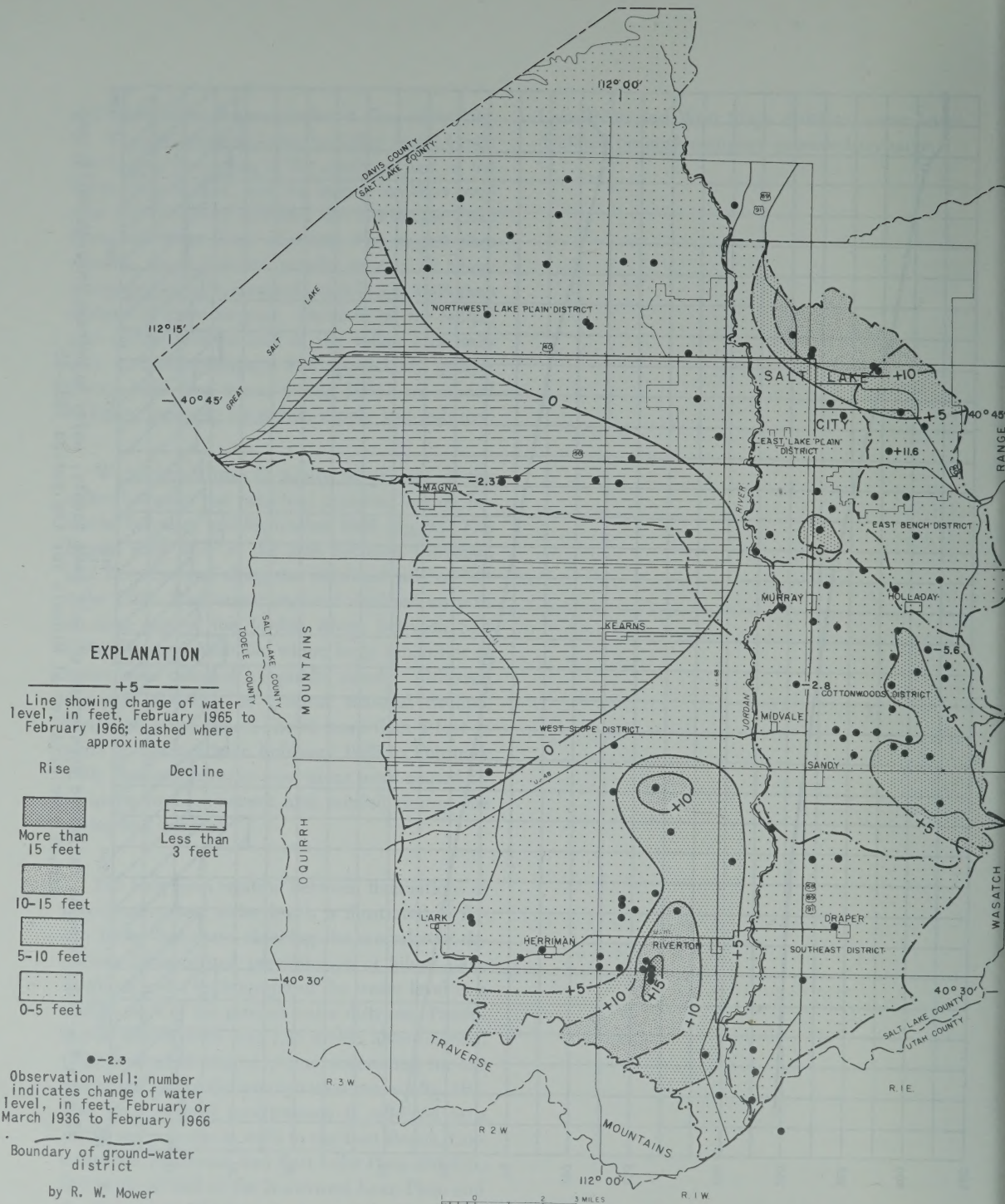


Figure 8.—Map of the Jordan Valley showing change of water levels from February 1965 to February 1966.

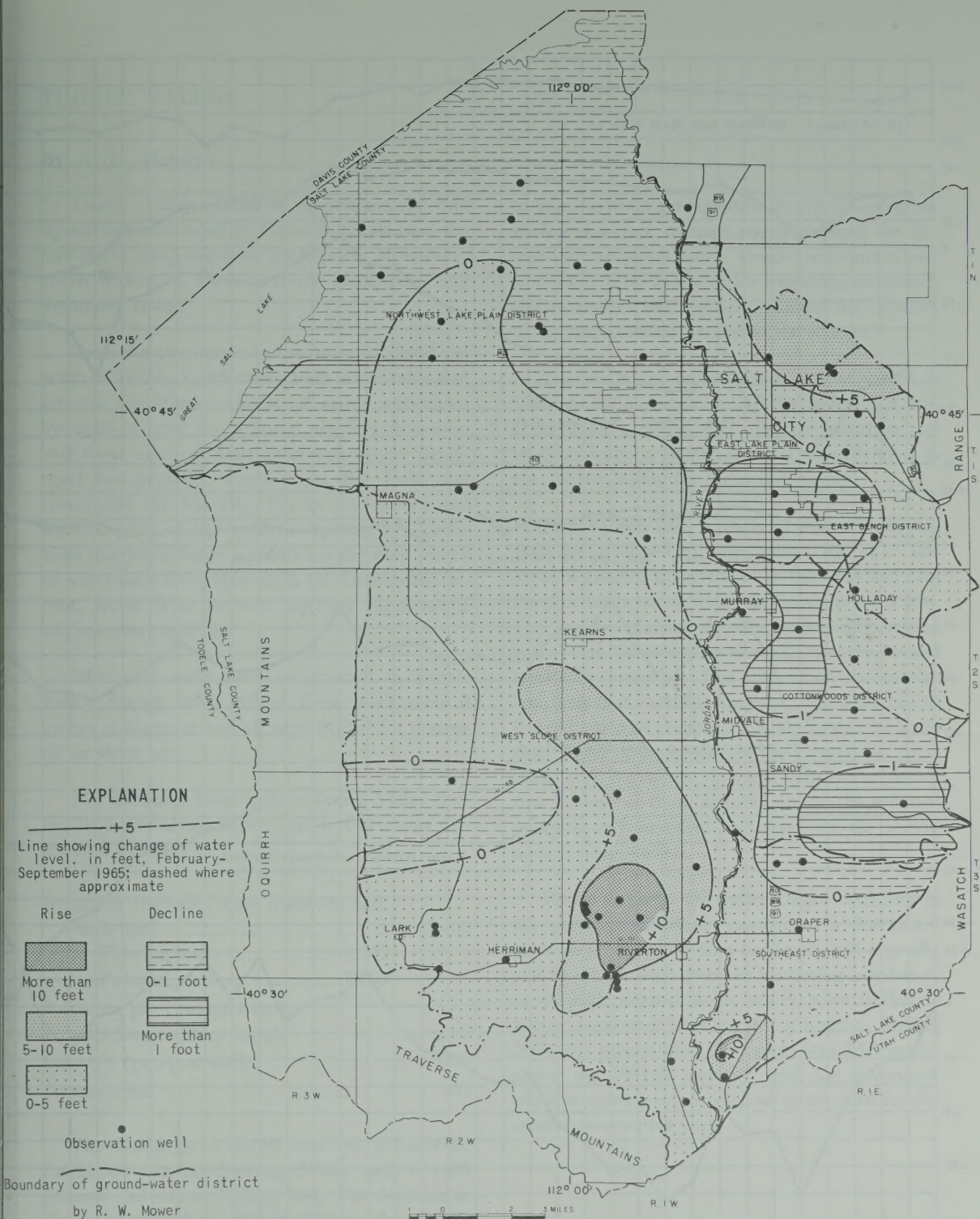


Figure 9.—Map of the Jordan Valley showing change of water levels from February to September 1965.

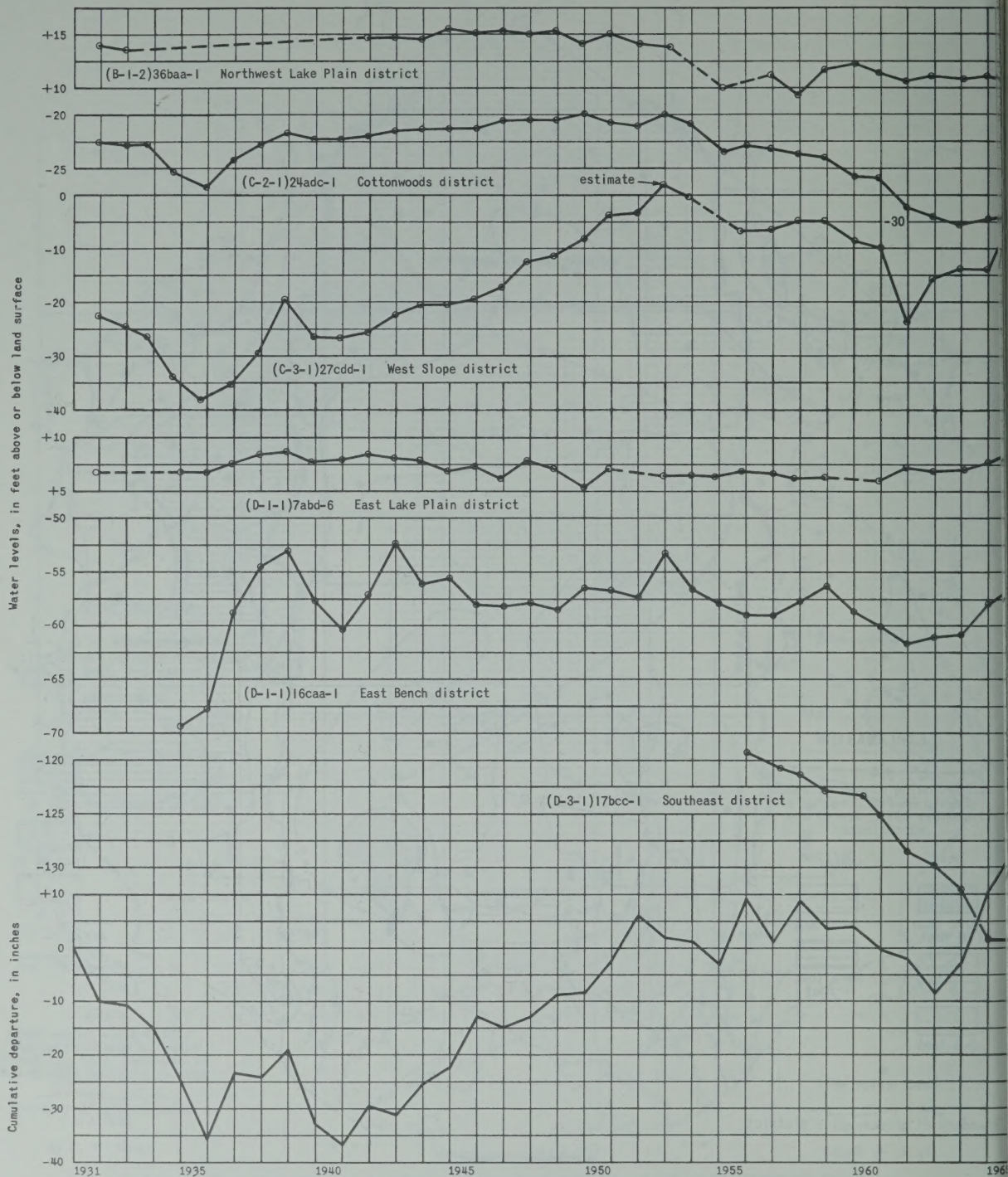


Figure 10.—Hydrographs showing relation of water levels in selected wells in the Jordan Valley to cumulative departure from the 1931-60 normal annual precipitation at Silver Lake Brighton.

TOOELE VALLEY

By A. H. Handy

Tooele Valley includes approximately 250 square miles bounded by Great Salt Lake and the foot of the steep slopes of the Oquirrh Mountains, South Mountain, the Stansbury Mountains, and Stansbury Island.

Ground water occurs in the unconsolidated deposits in Tooele Valley under both water-table and artesian conditions. Almost all water withdrawn by wells is from the artesian aquifers, however, and these aquifers have been extensively developed for irrigation supplies in the Erda and Grantsville districts (fig. 11) in the eastern and western parts of the valley, respectively. In the Erda district, artesian aquifers are the only source of water used for irrigation; in the Grantsville district, water from artesian aquifers supplements surface-water supplies.

Nine new wells were constructed in Tooele Valley during 1965. All of these wells were 6 inches in diameter and all were drilled for domestic or stock use.

The discharge from wells in Tooele Valley during 1965 was about 20,000 acre-feet of water distributed as follows:

Irrigation (includes some domestic and stock use)	17,400
Flowing wells	9,700
Pumped wells	7,700
Public supply (pumped wells; including military supply)	1,800
Industry (pumped wells)	400
Domestic use	100

The discharge of 20,000 acre-feet is less than the 21,000 acre-feet discharged from wells in 1964 (Arnow and others, 1965, p. 30). The decrease in the use of water from 1964 to 1965 was due mainly

to above-normal precipitation in April-September 1965 and a cool summer which reduced the demand for irrigation water. Greater amounts of surface water were available for irrigation, industrial, and municipal use, further reducing the demand upon supplemental ground-water sources.

The discharge from springs in the valley in 1965 was estimated to be 15,000 acre-feet. Of this, about 5,000 acre-feet was used for irrigation and stock and about 10,000 acre-feet was diverted to the Jordan Valley for industrial supply.

Water levels rose in parts of Tooele Valley in 1965 but declined in other parts (fig. 11). The areas of greatest decline were in the Erda and Mill Pond districts where levels declined almost 2 feet. The areas of decline contain large-yield pumped wells, and the water-level declines were caused mostly by pumping. The amount of decline was less than that in 1964, however, due probably to the reduction of pumping. Water levels rose more than 2 feet in some parts of the Grantsville, Marshall, and Burmester districts. The water levels rose in most of these districts due to the reduced pumping and increased recharge from the above-normal precipitation.

Water levels in the valley began declining in the period 1949-52 in response to a downward trend in precipitation that began in 1948 (fig. 12) and to withdrawals from an increasing number of large-yield pumped wells, which were drilled to supply supplemental water for irrigation. During 1965, the precipitation at Tooele was 2.98 inches above the 1931-65 average, and the downward trend in water levels leveled off or reversed for the second consecutive year.

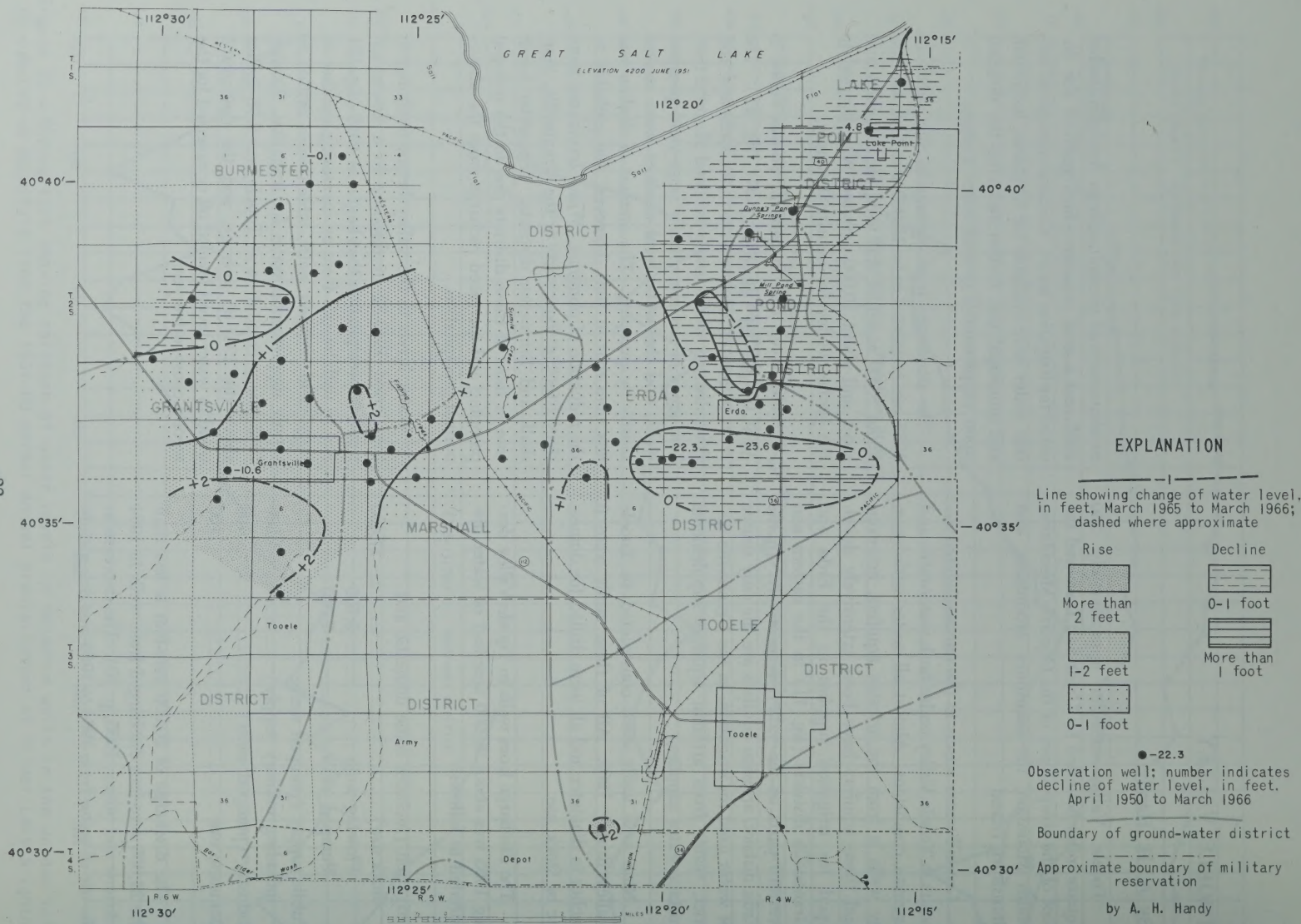


Figure 11.—Map of Tooele Valley showing change of water levels in artesian aquifers, March 1965 to March 1966.

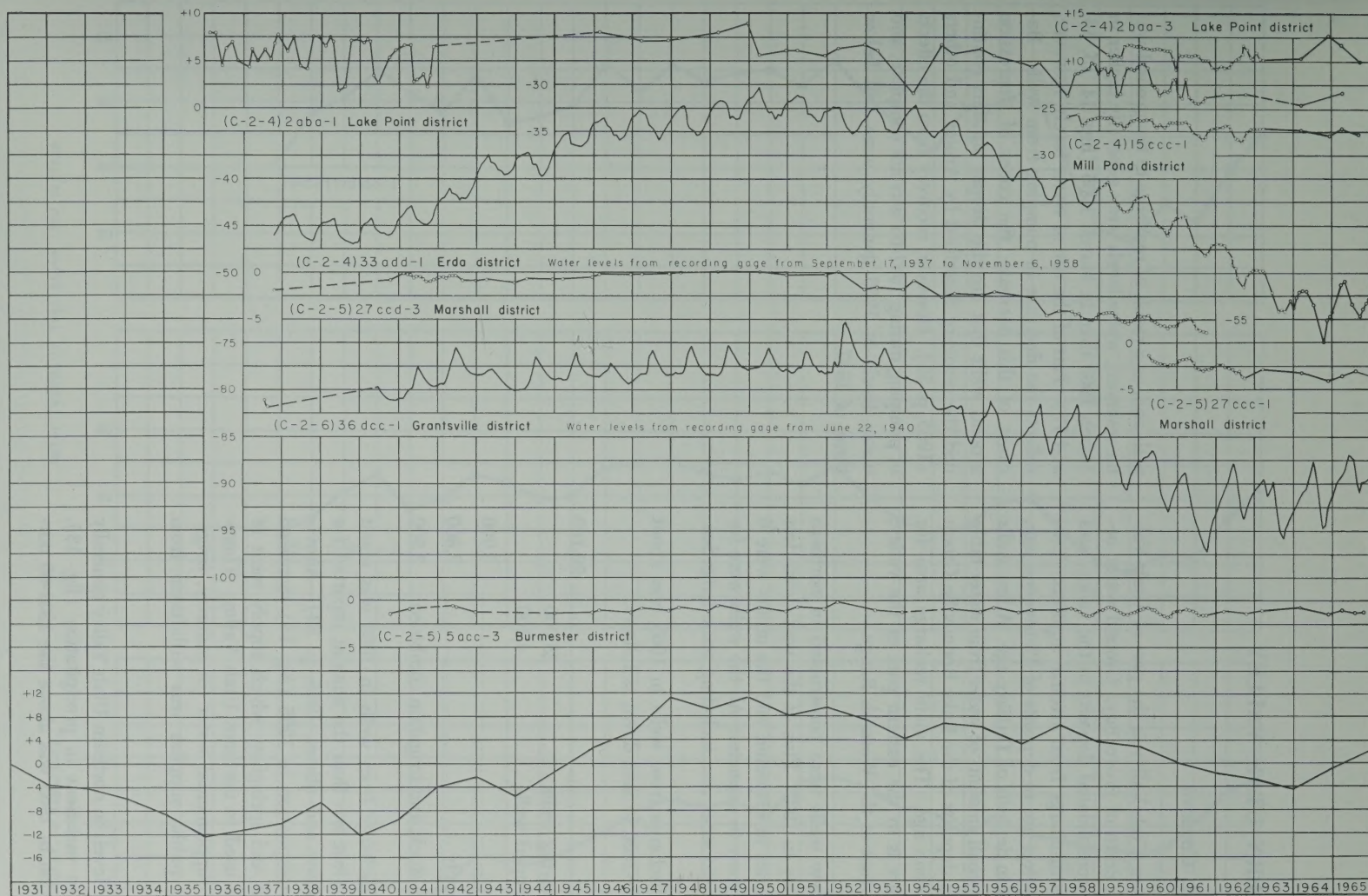


Figure 12.—Hydrographs showing relation of water levels in selected wells in Tooele Valley to cumulative departure from the 1931-60 normal annual precipitation at Tooele.

NORTHERN UTAH VALLEY

By R. M. Cordova

Northern Utah Valley is the part of Utah Valley that is north of Provo Bay. Ground water occurs in unconsolidated deposits in the valley, and most wells discharge from artesian aquifers. Two of the aquifers are in deposits of Pleistocene age, and one is in deposits of Tertiary age. A few wells withdraw small amounts of water from water-table aquifers in deposits of the Lake Bonneville Group of Pleistocene age. The main recharge area for the aquifers is in the eastern part of the valley, along the foot of the Wasatch Range.

Ten new wells were constructed in northern Utah Valley in 1965. Five of the wells were less than 6 inches in diameter, and the others were 6 inches or more in diameter. All the wells were for domestic and stock use, including some irrigation.

The discharge from wells in 1965 was about 42,000 acre-feet, broken down as follows:

Irrigation	29,100
Flowing wells	25,000
Pumped wells	4,100
Industry	6,900
Public supply	3,800
Domestic, stock, and irrigation combined ..	2,500

The discharge from wells in 1965 was about 4,000 acre-feet less than the amount reported for 1964 (Arnou and others, 1965, p. 33). Above-normal precipitation in 1965 (fig. 13) increased the runoff and springflow which supply most of the water used in northern Utah Valley. Therefore, less supplemental water for industry, irrigation, and public supplies was withdrawn from wells.

Water levels in northern Utah Valley generally respond to variations in precipitation (fig. 13). Precipitation in 1965 was above the 1931-60 nor-

mal; and, as a result of recharge to the ground-water reservoir, water levels were generally higher in March 1966 than in March 1965 (figs. 14, 15, 16, and 17). Part of the rise of water levels, however, reflects the decrease in pumping from wells. Because of this decrease, the cones of depression around wells that tap the deeper aquifers continued the recovery described by Arnou and others (1965, p. 33). However, recovery from the effects of pumping during 1947-63 was not complete, and water levels in 1966 generally were still below those of 1947.

Water levels, in feet above land surface

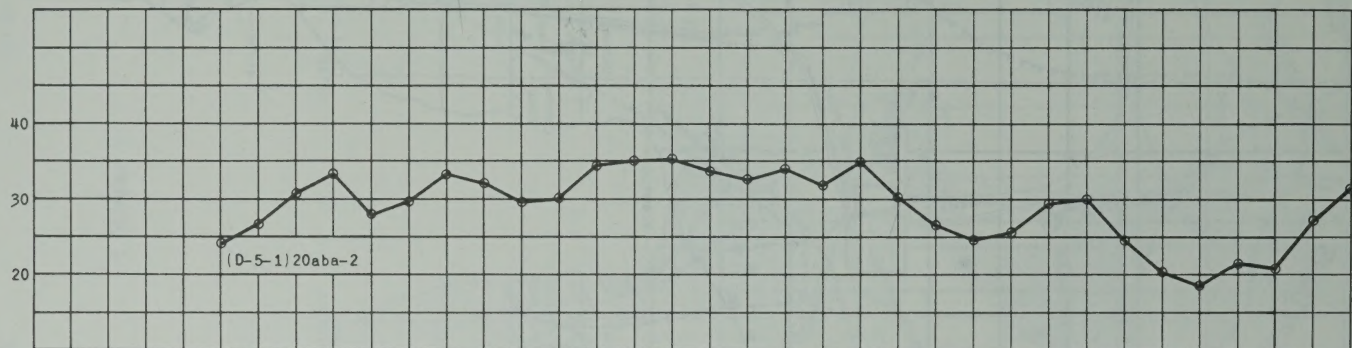
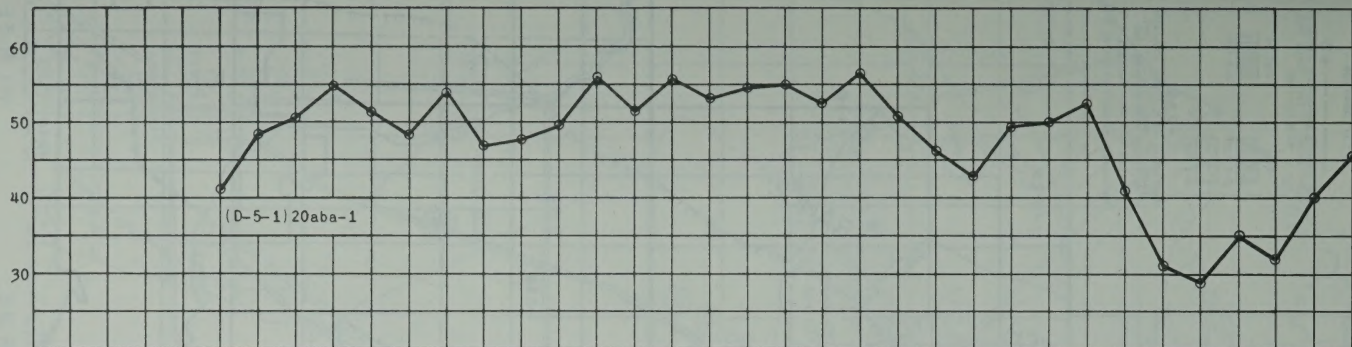
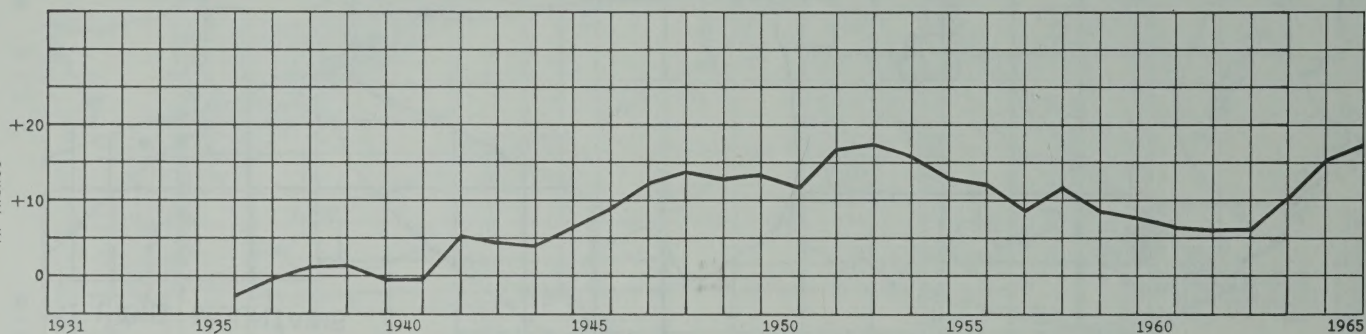
Cumulative departure,
in inches

Figure 13.—Hydrographs showing relation of water levels in wells (D-5-1)20aba-1 and (D-5-1)20aba-2 to cumulative departure from the 1931-60 normal annual precipitation at Utah Lake Lehi.

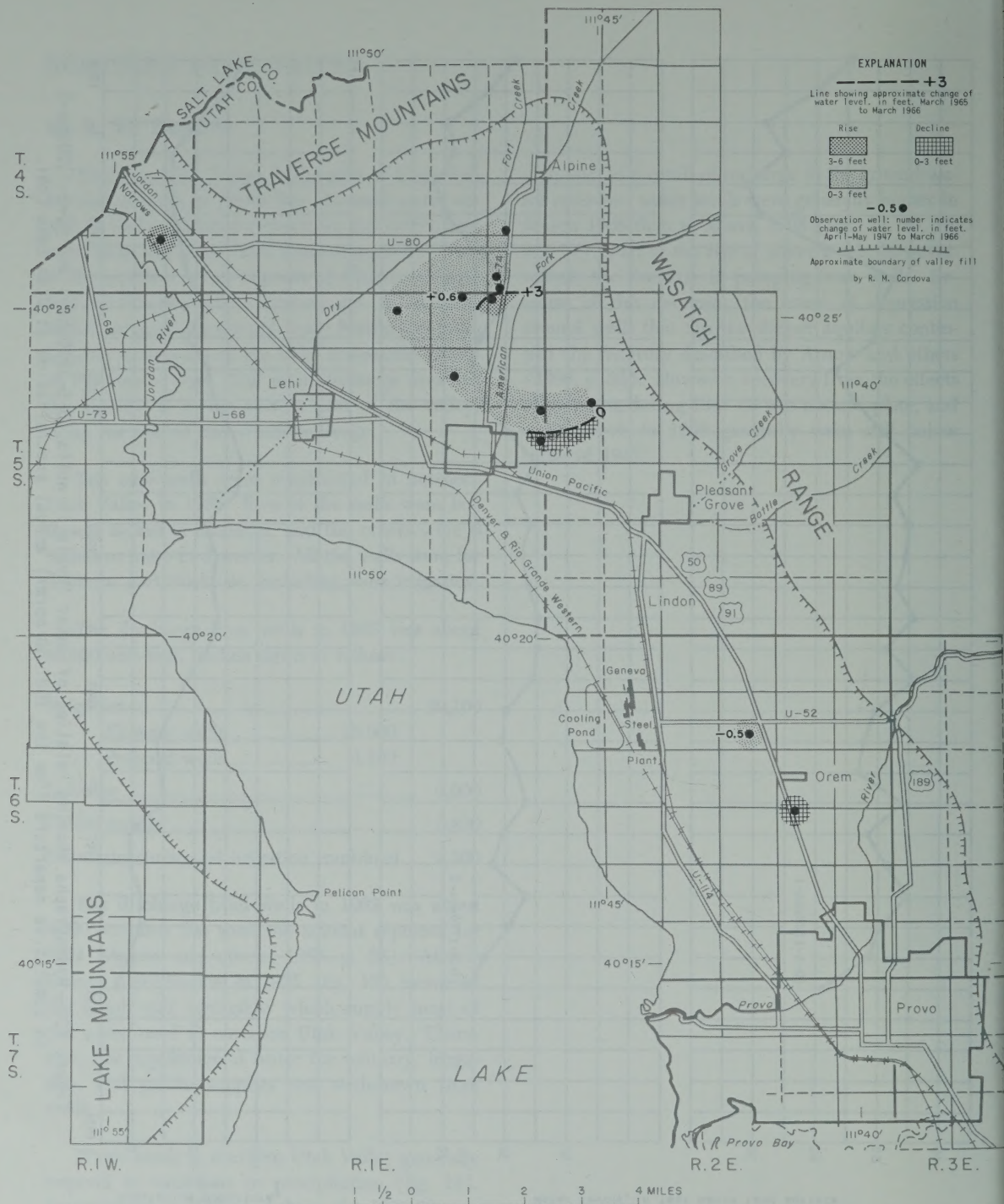


Figure 14.—Map of northern Utah Valley showing change of water levels in the water-table aquifer in the Lake Bonneville Group, March 1965 to March 1966.

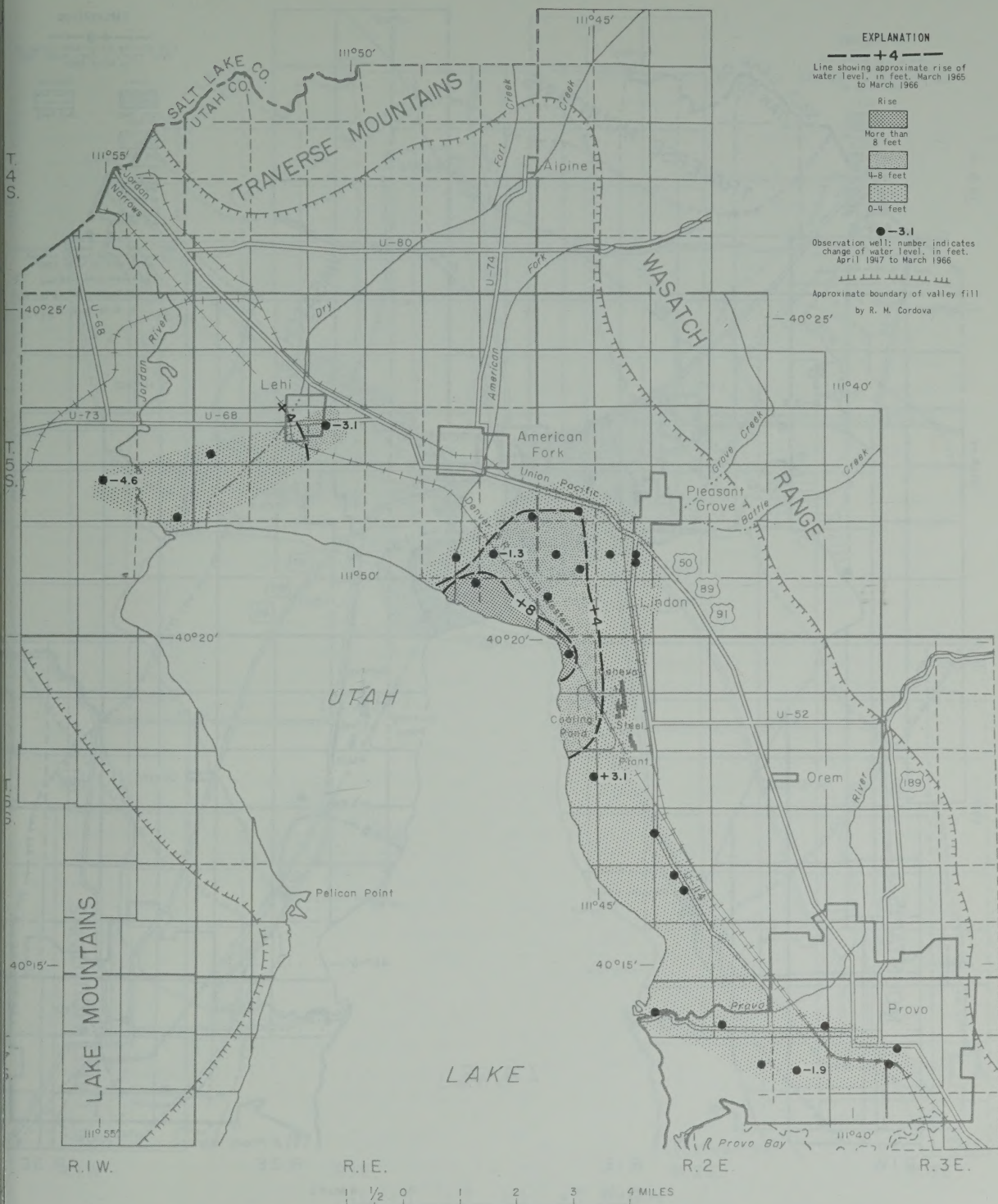


Figure 15.—Map of northern Utah Valley showing change of water levels in the shallow aquifer in rocks of Pleistocene age, March 1965 to March 1966.

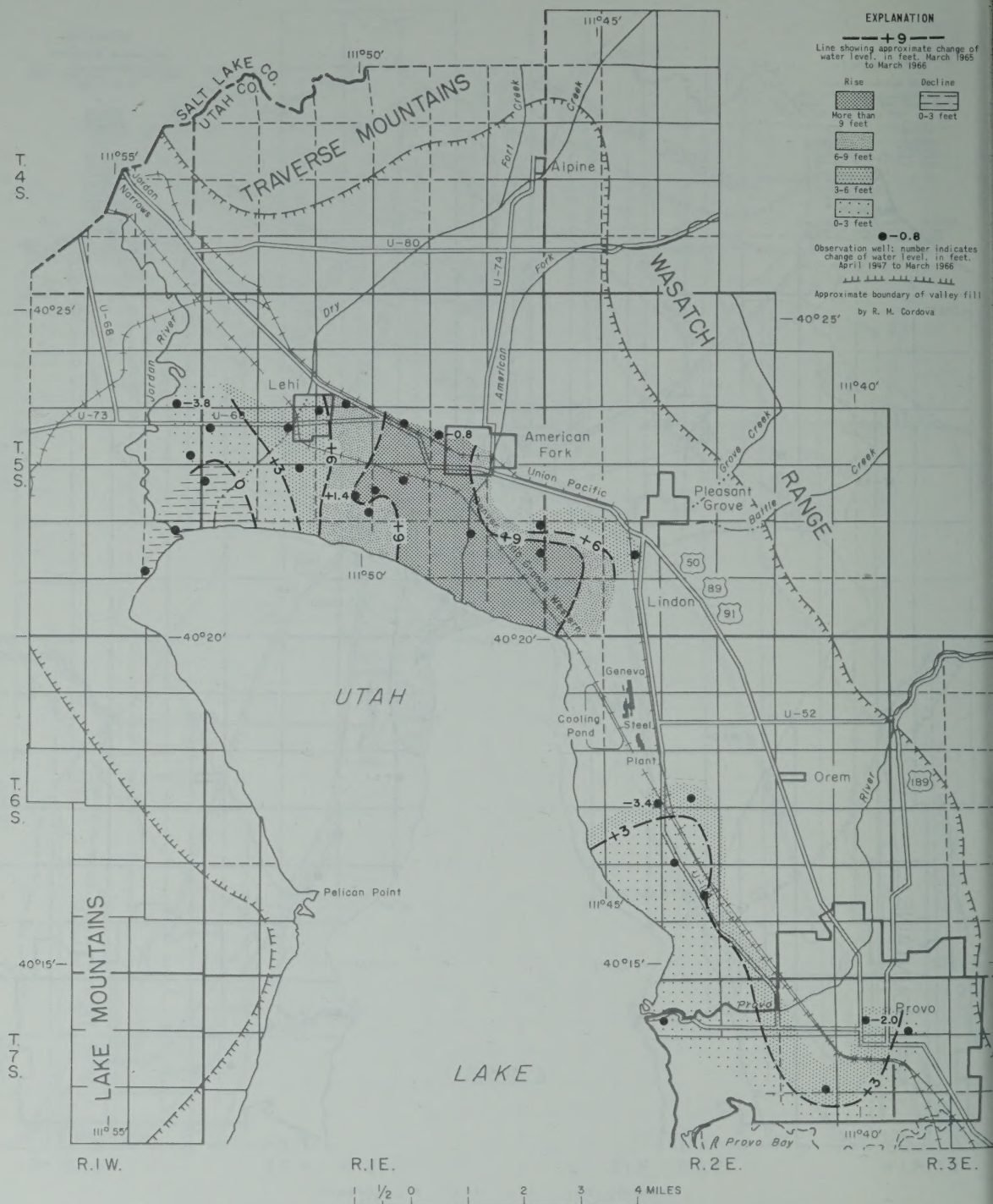


Figure 16.—Map of northern Utah Valley showing change of water levels in the deep aquifer in rocks of Pleistocene age, March 1965 to March 1966.

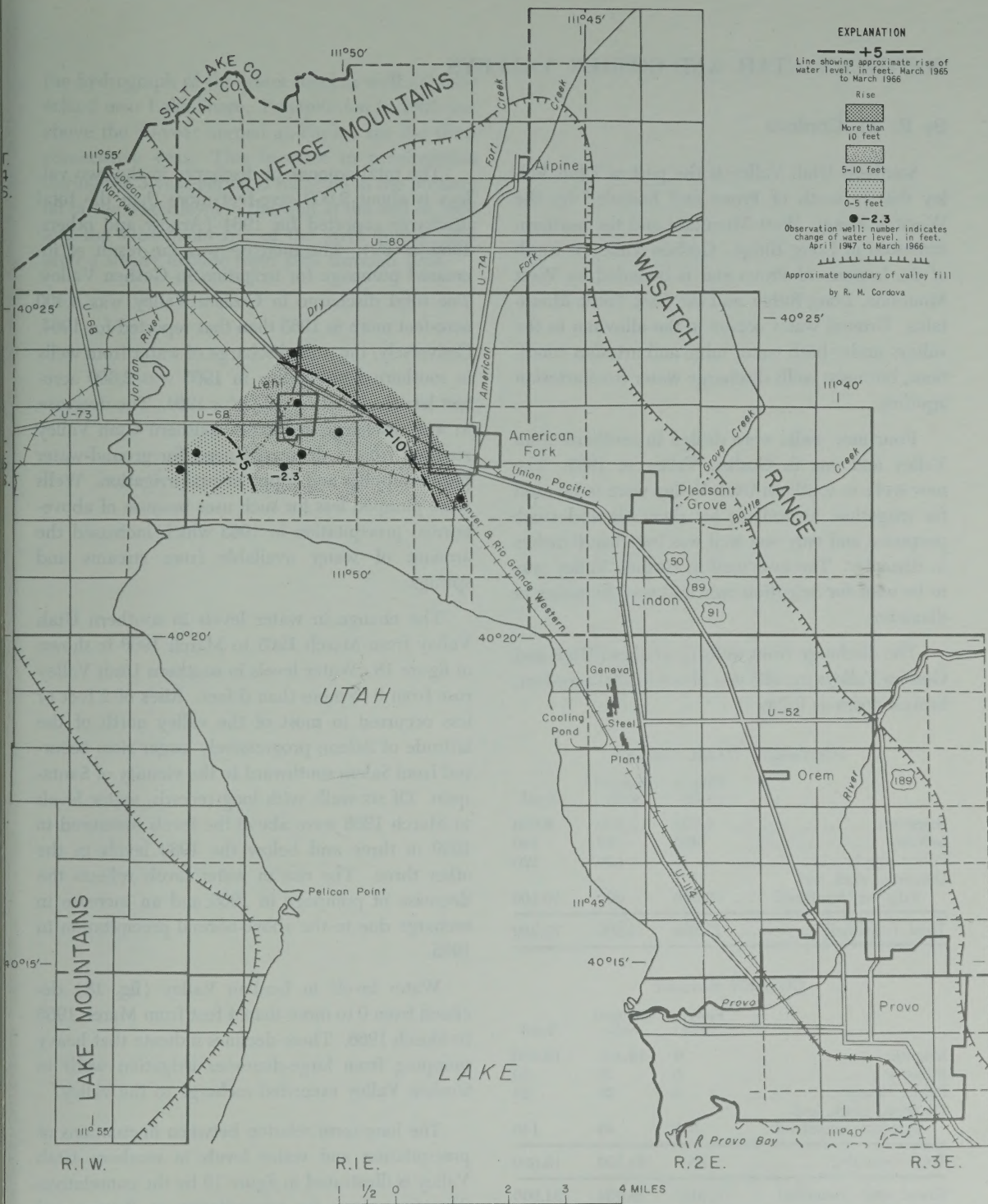


Figure 17.—Map of northern Utah Valley showing change of water levels in the aquifer in rocks of Tertiary age, March 1965 to March 1966.

SOUTHERN UTAH AND GOSHEN VALLEYS

By R. M. Cordova

Southern Utah Valley is the part of Utah Valley that is south of Provo and bounded by the Wasatch Range, West Mountain and the northern extension of Long Ridge. Goshen Valley is south of the latitude of Provo and is bounded by West Mountain, Long Ridge, and the East Tintic Mountains. Ground water occurs in the alluvium in the valleys under both water-table and artesian conditions, but most wells discharge water from artesian aquifers.

Four new wells were drilled in southern Utah Valley and one in Goshen Valley in 1965. The new wells in southern Utah Valley were to be used for irrigation, as well as for domestic and stock purposes; and only one well was less than 6 inches in diameter. The new well in Goshen Valley was to be used for irrigation only and was 20 inches in diameter.

The discharge from wells in southern Utah and Goshen Valleys in 1965 was about 31,000 acre-feet, broken down as follows:

SOUTHERN UTAH VALLEY

	Flowing wells	Pumped wells	Total
Irrigation	2,900	3,700	6,600
Industry	400	140	540
Public supply	0	120	120
Domestic, stock and irrigation combined	9,500	600	10,100
Total (rounded)	12,800	4,600	17,400

GOSHEN VALLEY

	Flowing wells	Pumped wells	Total
Irrigation	0	13,400	13,400
Industry	0	30	30
Public supply	0	20	20
Domestic, stock, and irrigation combined	100	40	140
Total (rounded)	100	13,500	13,600
Grand total (rounded)	13,000	18,000	31,000

The total amount of discharge in the two valleys is about 2,000 acre-feet more than the total discharge reported for 1964 (Arnold and others, 1965, p. 39). The increase was the result of increased pumpage for irrigation in Goshen Valley. The total discharge in Goshen Valley was 4,400 acre-feet more in 1965 than that reported for 1964. Conversely, the total discharge of water from wells in southern Utah Valley in 1965 was 2,300 acre-feet less than that reported for 1964. The decrease in well discharge in 1965 in southern Utah Valley resulted from a decreased need for ground-water public supplies and supplemental irrigation. Wells were pumped less for such uses because of above-normal precipitation in 1965 which increased the amount of water available from streams and springs.

The change in water levels in southern Utah Valley from March 1965 to March 1966 is shown in figure 18. Water levels in southern Utah Valley rose from 0 to more than 6 feet. Rises of 2 feet or less occurred in most of the valley north of the latitude of Salem; progressively larger rises occurred from Salem southward to the vicinity of Santaquin. Of six wells with long records, water levels in March 1966 were above the levels measured in 1939 in three and below the 1939 levels in the other three. The rise in water levels reflects the decrease of pumpage in 1965 and an increase in recharge due to the above-normal precipitation in 1965.

Water levels in Goshen Valley (fig. 18) declined from 0 to more than 4 feet from March 1965 to March 1966. These declines indicate that heavy pumping from large-diameter irrigation wells in Goshen Valley exceeded recharge to the valley.

The long-term relation between fluctuations of precipitation and water levels in southern Utah Valley is illustrated in figure 19 by the cumulative-departure curve for precipitation at Payson and

the hydrograph of the water level in well (D-8-2) 4cba-2 near Lake Shore. Precipitation in 1965 was above the 30-year normal at Payson for the third consecutive year. This increase in precipitation during the 3-year period is reflected in the leveling off of the water level in the well at the end of 1964 and the subsequent rise of the level during 1965 after a steady decline from 1957 through 1963.



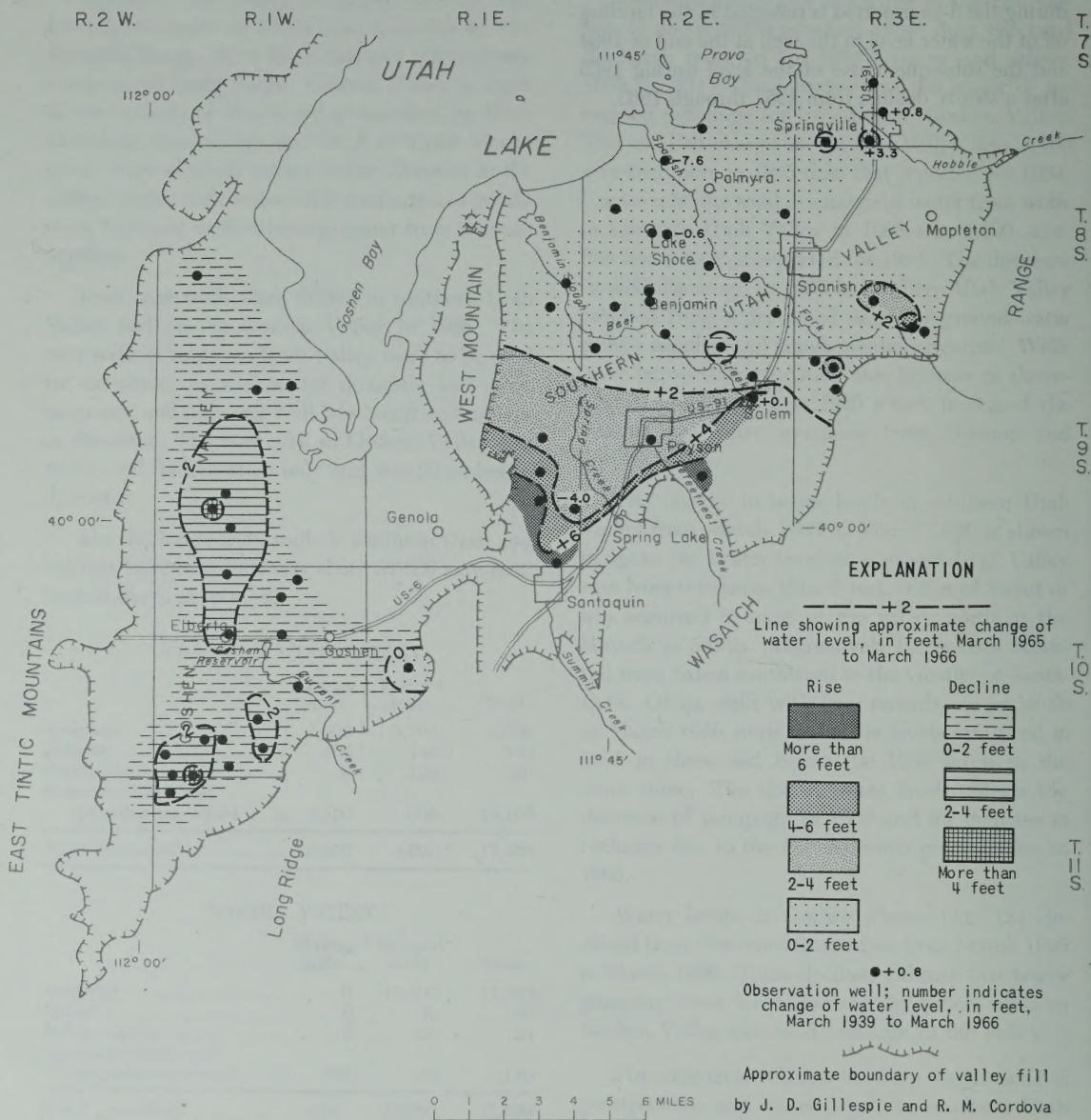


Figure 18.—Map of southern Utah and Goshen Valleys showing change of water levels, March 1965 to March 1966.

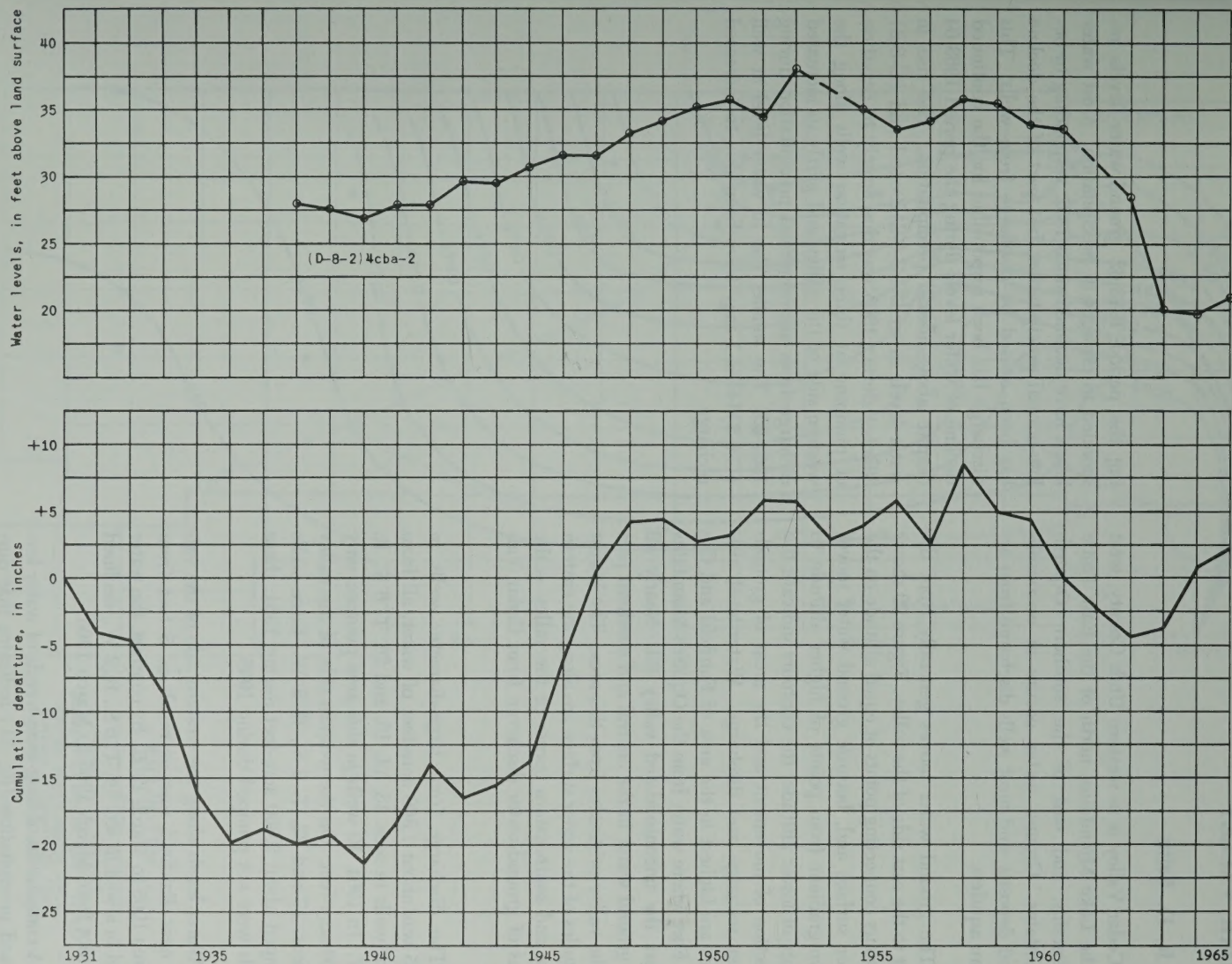


Figure 19.—Hydrograph showing relation of water levels in well (D-8-2)4cba-2 near Lake Shore to cumulative departure from the 1931-60 normal annual precipitation at Payson.

CEDAR VALLEY

By R. D. Feltis

Cedar Valley is in western Utah County, west of the Lake Mountains, north of the East Tintic Mountains, and east of the southern Oquirrh Mountains. Ground water occurs in unconsolidated deposits, and most wells discharge from artesian aquifers.

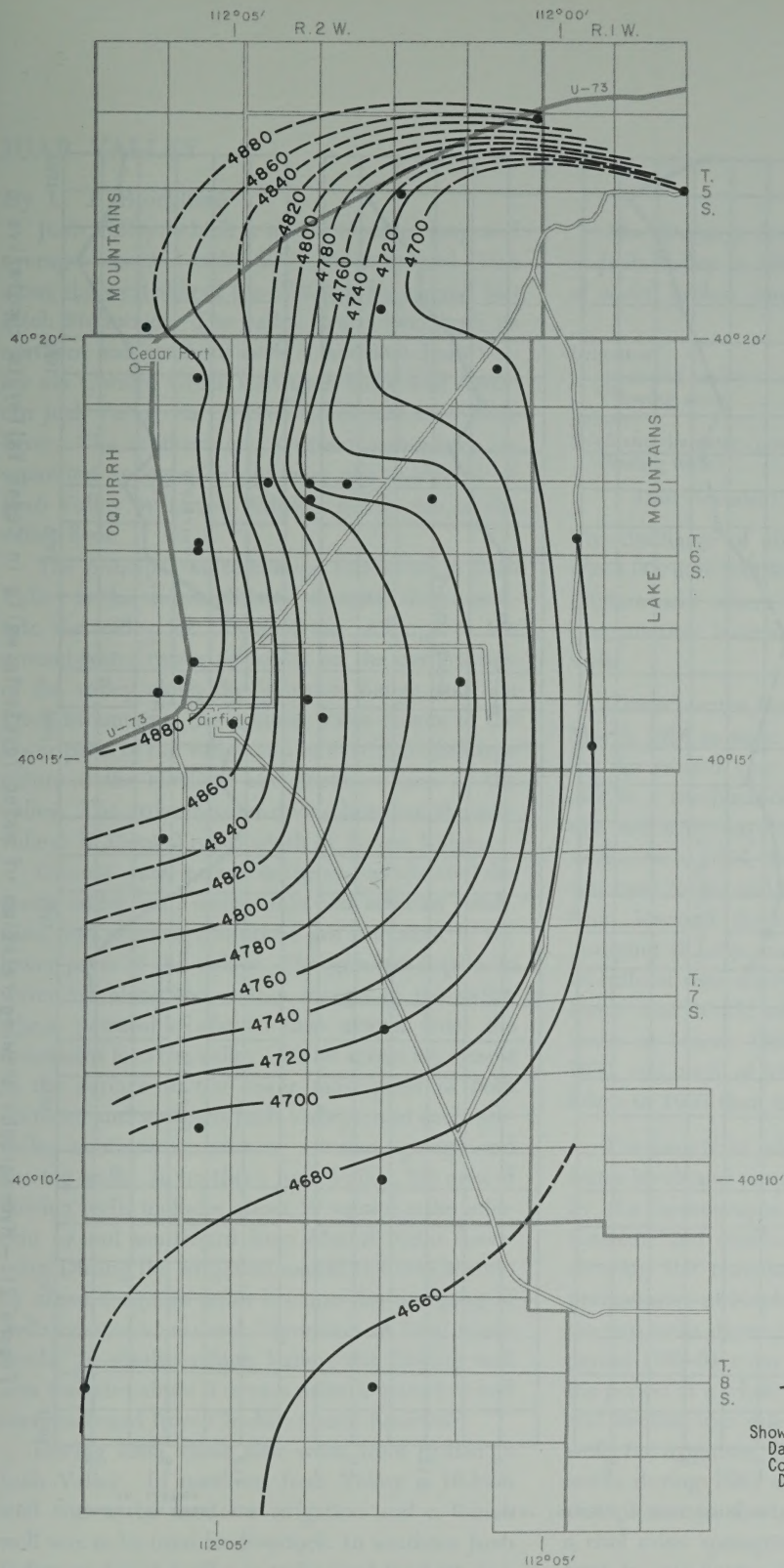
The ground water moves generally from the west to the east side of the valley. Figure 20 shows contours connecting points of equal altitude on the water surface and, because ground water moves down-gradient from points of higher altitude to points of lower altitude, the contours indicate the direction of movement and the areas of ground-water recharge and discharge. Water-level altitudes are highest in the area of Fairfield and Cedar Fort where water from the Oquirrh Mountains enters the unconsolidated valley fill. Nearly all the ground water in the central and southern part of the valley originates from this area. The lowest altitudes of the water surface are along the eastern edge and southeastern corner of the valley — the areas of ground-water discharge from Cedar Valley.

The discharge from large-diameter wells in 1965 was about 1,800 acre-feet of water, all from eight wells in secs. 13, 14, 15, and 26, T. 6 S., R. 2 W. In 1964, 10 wells in this area pumped only 1,200 acre-feet. On the western side of the valley in secs. 17 and 32, T. 6 S., R. 2 W., three wells pumped about 2,600 acre-feet during 1964; these wells were not pumped during 1965.

Water levels along the western side of the valley near Fairfield rose as much as 5 feet from March 1965 to March 1966. By contrast, the water level in a well in sec. 14, T. 6 S., R. 2 W., declined 0.6 foot from March 1965 to March 1966.

A comparison of long-term trends of water levels and precipitation (fig. 21) indicates that dur-

ing the period 1943-62 ground-water levels responded to changes in precipitation. Most water levels have declined since 1952, responding to below-normal precipitation, but part of the decline has been caused by discharge from wells. This discharge has been responsible for the continued decline of water levels during the period 1963-64 despite above-normal precipitation. The rise in water levels in wells (C-6-2)29cac-1 and (C-6-2)33bcb-1 during 1965 was due largely to cessation of pumping at three irrigation wells along the western side of the valley and partly to increased recharge from above-normal precipitation during 1964-65. The smaller rise in water level at well (C-6-2)14cba-1 may have been due to increased recharge.



EXPLANATION

— 4700 — — —
 Water-level contour
 Shows altitude of water level.
 Dashed where approximate.
 Contour interval 20 feet.
 Datum is mean sea level

•
 Observation well
 by R. D. Feltis

Figure 20.—Map of Cedar Valley showing water-level contours, March 1966.

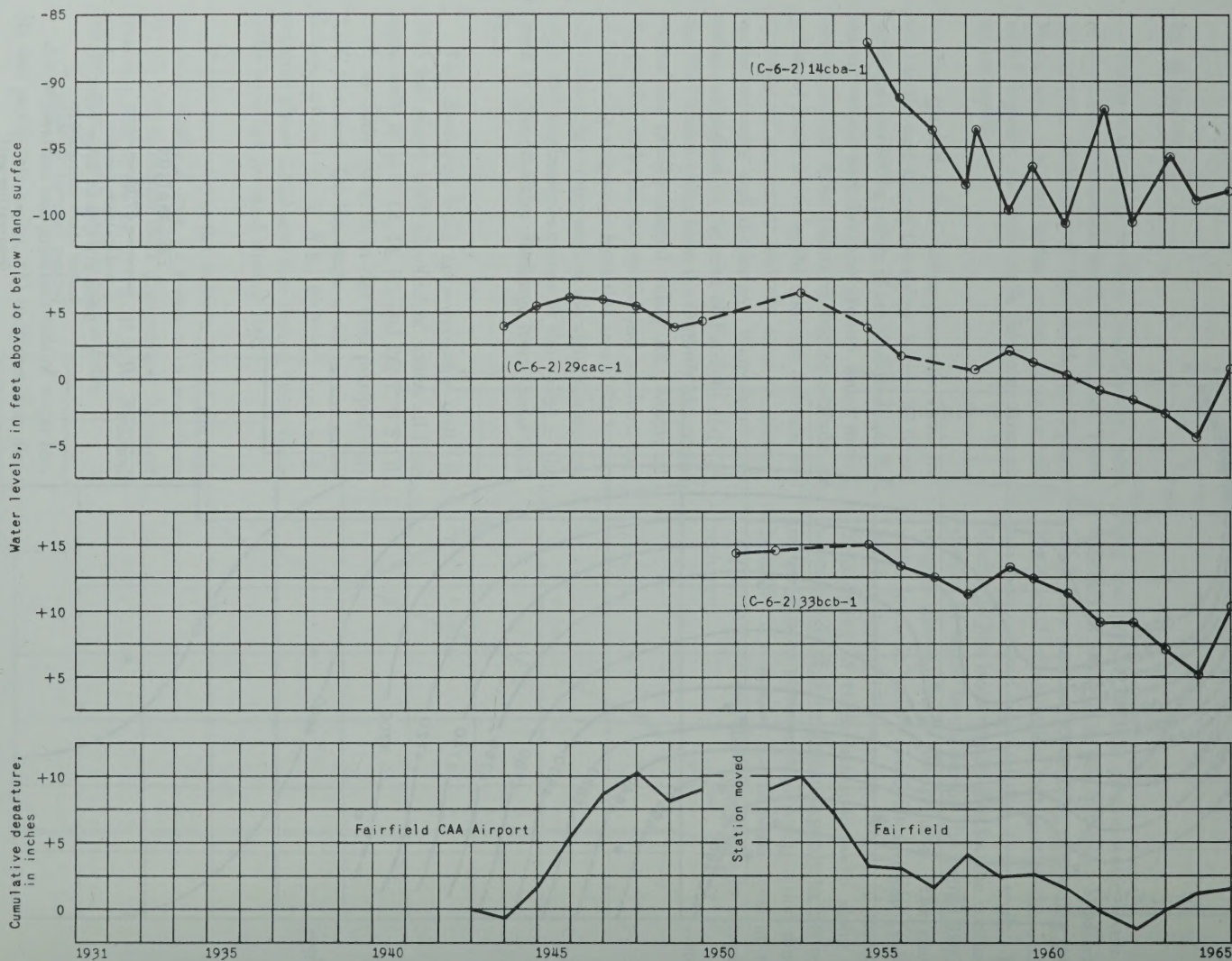


Figure 21.—Hydrographs showing relation of water levels in wells in Cedar Valley to cumulative departure from the 1943-63 average annual precipitation at Fairfield.

JUAB VALLEY

By L. J. Bjorklund

Juab Valley, which is about 40 miles long and averages about 4 miles wide, is in central Utah along the west side of the Wasatch Range and San Pitch Mountains. The valley drains near both its northern and southern ends — northern Juab Valley via Current Creek into Utah Lake and southern Juab Valley via Chicken Creek into the Sevier River. The northern and southern subvalleys are separated topographically near the midpoint of Juab Valley by Levan Ridge, a gentle rise of the valley floor.

The principal water-bearing formation in Juab Valley is the unconsolidated deposits that constitute the valley fill. Most of the recharge to the ground-water reservoir occurs on the eastern side of the valley along the Wasatch Range and San Pitch Mountains; the ground water moves to the lower parts of the valley and to eventual discharge points at the northern and southern ends of the valley. The ground-water divide between the subvalleys is about 2 miles south of Levan Ridge.

Ground water occurs in the unconsolidated deposits under both water-table and artesian conditions, but artesian conditions are prevalent in the lower parts of the valley. The greatest depths to water are along the eastern margin of the valley where permeable alluvial fans extend from the mountains into the valley. Water levels are closest to the surface in the lower most parts of both northern and southern Juab Valleys, and each subvalley contains an area of artesian springs and flowing wells. In northern Juab Valley, the area of flowing wells includes about 10 square miles adjacent to and southward from Mount Nebo Reservoir. During the irrigation season the area shrinks by about 2 square miles because the pumping of wells creates a seasonal depression of local water levels. In southern Juab Valley, the flowing well area includes about 6 square miles adjacent to and northeastward from Chicken Creek Reservoir.

During 1965, three new wells were drilled in Juab Valley. In northern Juab Valley a 16-inch well was to be used for irrigation and a 6-inch well was to be used for livestock. In southern Juab Valley an 8-inch well was to be used for both irrigation and livestock.

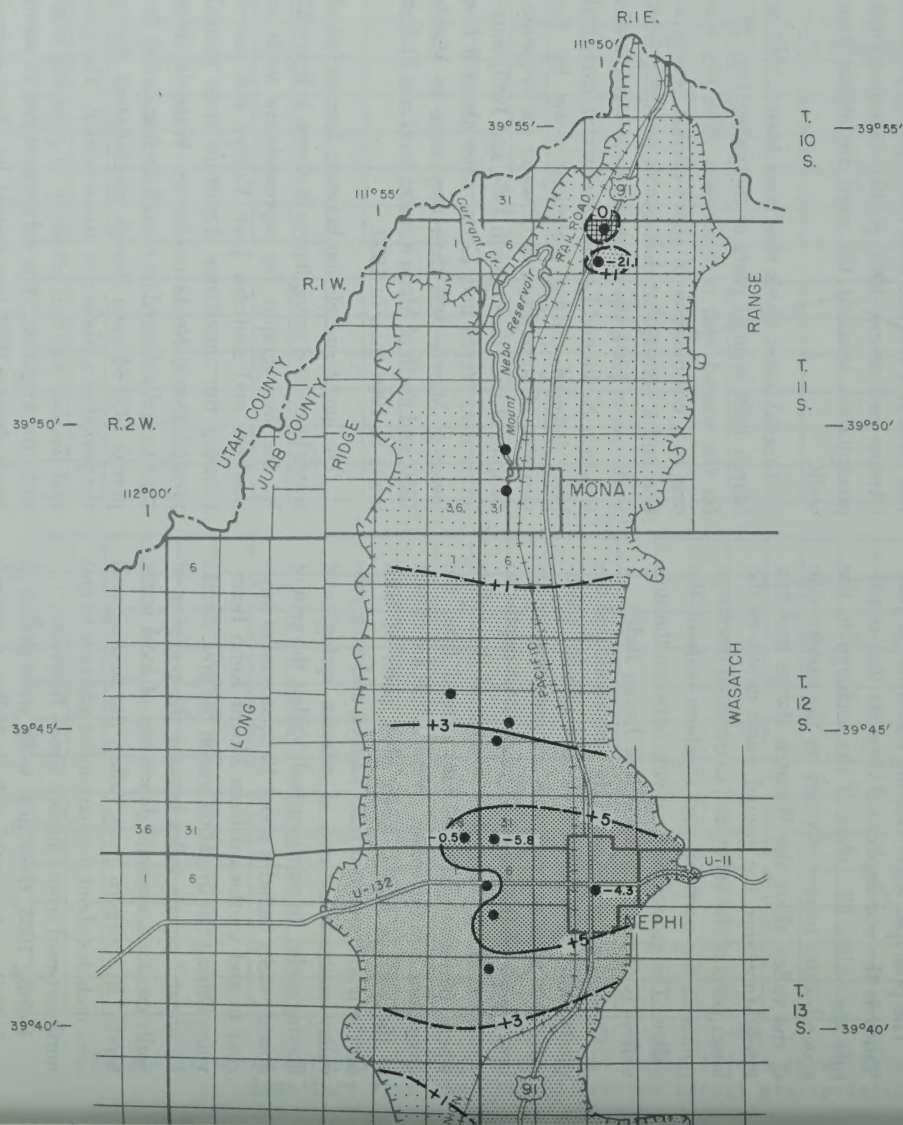
The discharge from pumped and flowing wells in Juab Valley in 1965 was about 18,000 acre-feet of water, broken down as follows:

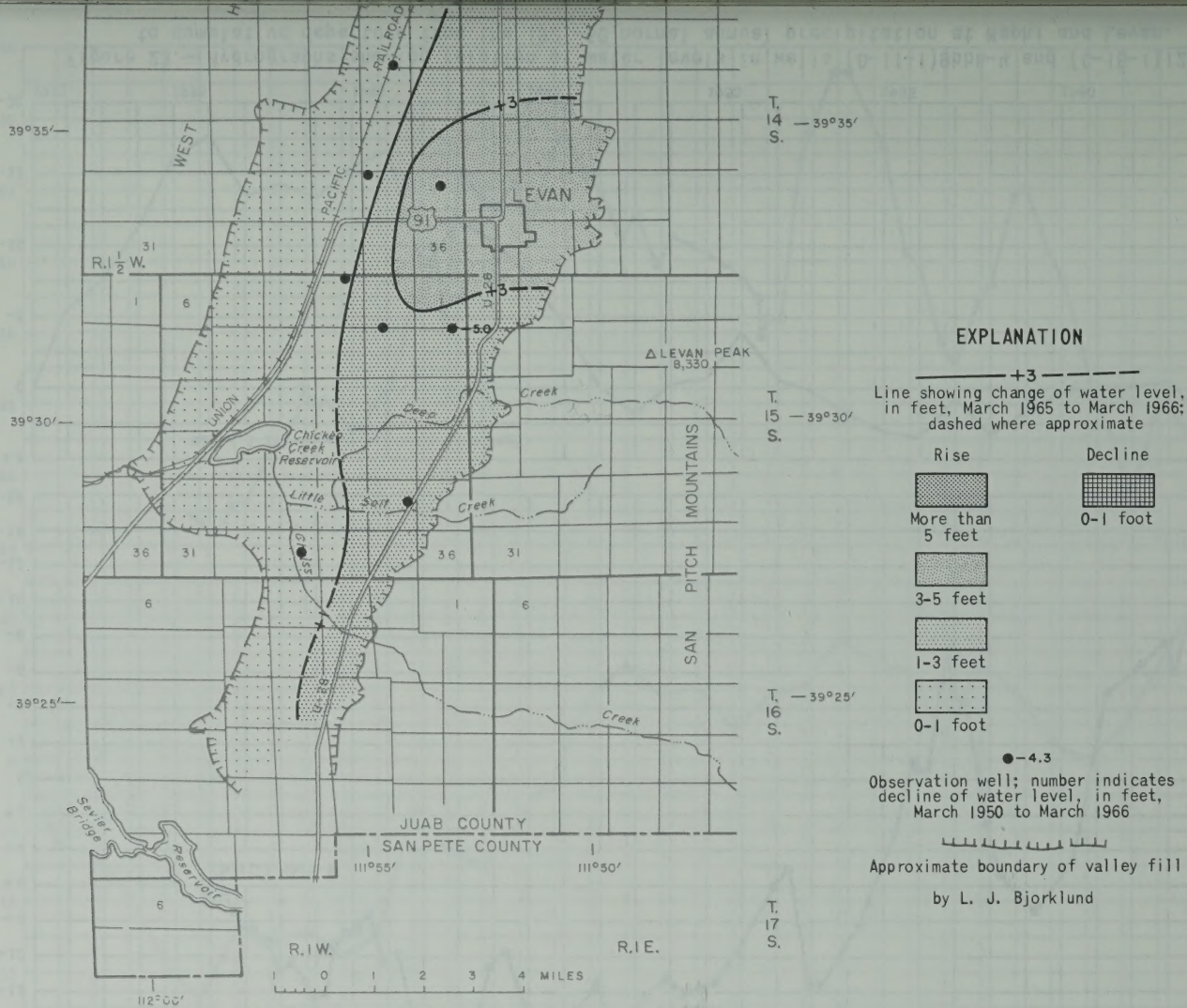
	Northern Juab Valley	Southern Juab Valley
Irrigation		
(pumped wells)	12,200	1,800
(flowing wells)	2,500	1,200
Industry	50	0
Stock and domestic (pumped and flowing wells)	100	40
Total (rounded)	14,800	3,000

The discharge of about 18,000 acre-feet in 1965 was 1,000 acre-feet less than that reported for 1964 (Arnow and others, 1965, p. 49). Above-normal precipitation lessened the need for water from wells.

Ground-water levels rose from March 1965 to March 1966 in most parts of the valley (fig. 22) for the second year in succession. The rise was due to a combination of above-normal precipitation and a consequent decrease in pumping from wells. As in 1964, the greatest rise in water levels was near Nephi and Levan where water levels had been lowered during preceding years by the pumping of large amounts of water for irrigation. In spite of rises during both 1964 and 1965, water levels near Nephi and Levan were about 5 feet lower in March 1966 than they were in March 1950, and north of Mona a water level was 21 feet lower in 1966 than in 1950.

The long-term relation between fluctuations of water levels and precipitation is shown in figure 23 by the hydrographs for representative wells in northern and southern Juab Valleys and curves showing the cumulative departure from normal precipitation at Nephi and Levan. Water levels in the two wells showed an overall decline during the period 1953-64 even though precipitation during the period as a whole was above normal. The general decline was due primarily to pumping from wells for irrigation. The subsequent rise in water levels during 1965 was caused by above-normal precipitation, a shortened irrigation season due to a cool rainy springtime, a snowstorm and killing frost in mid-September, and the consequent decrease of pumping for irrigation.





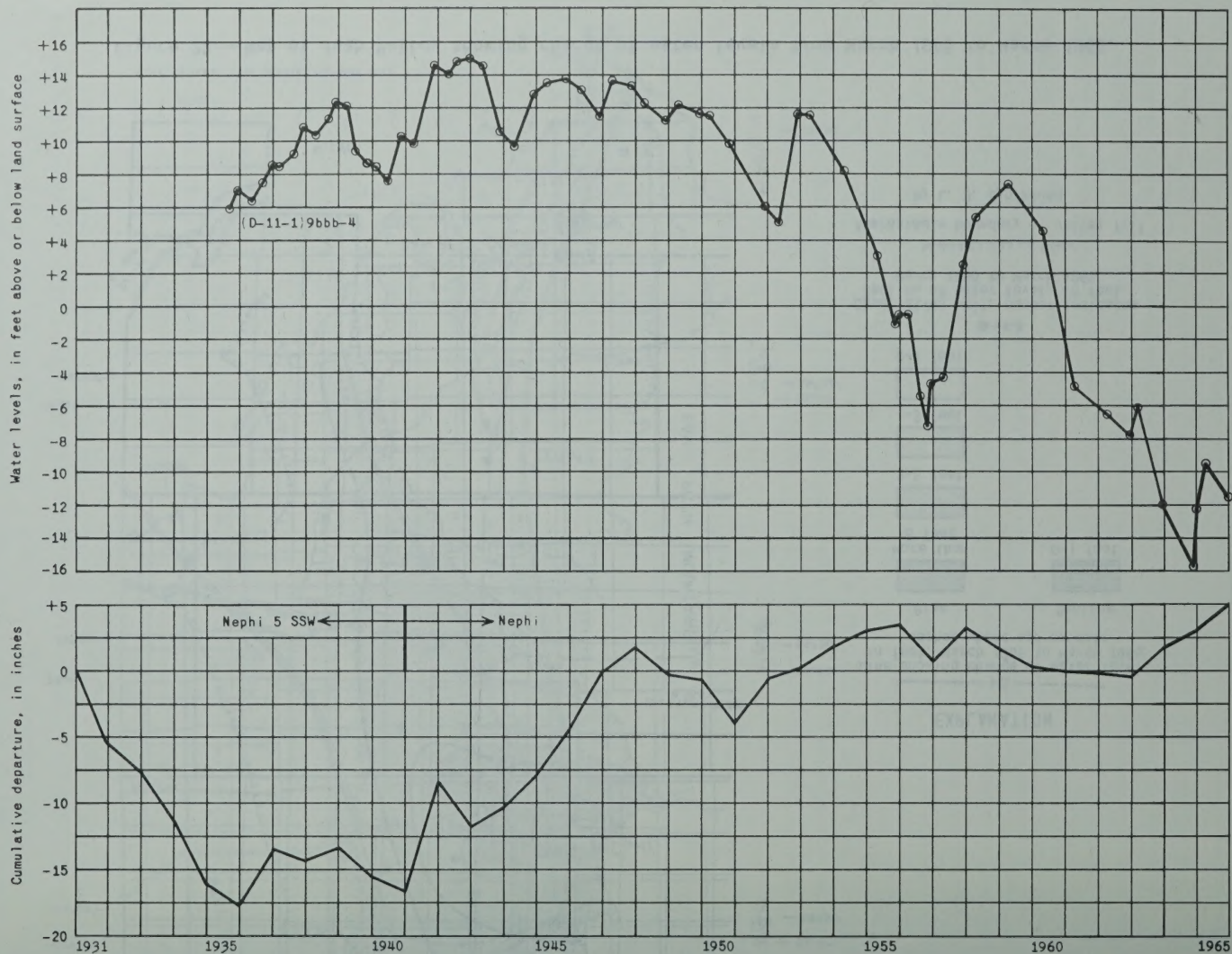


Figure 23.—Hydrographs showing relation of water levels in wells (D-11-1)9bbb-4 and (C-15-1)12aba-1 to cumulative departure from the 1931-60 normal annual precipitation at Nephi and Levan.

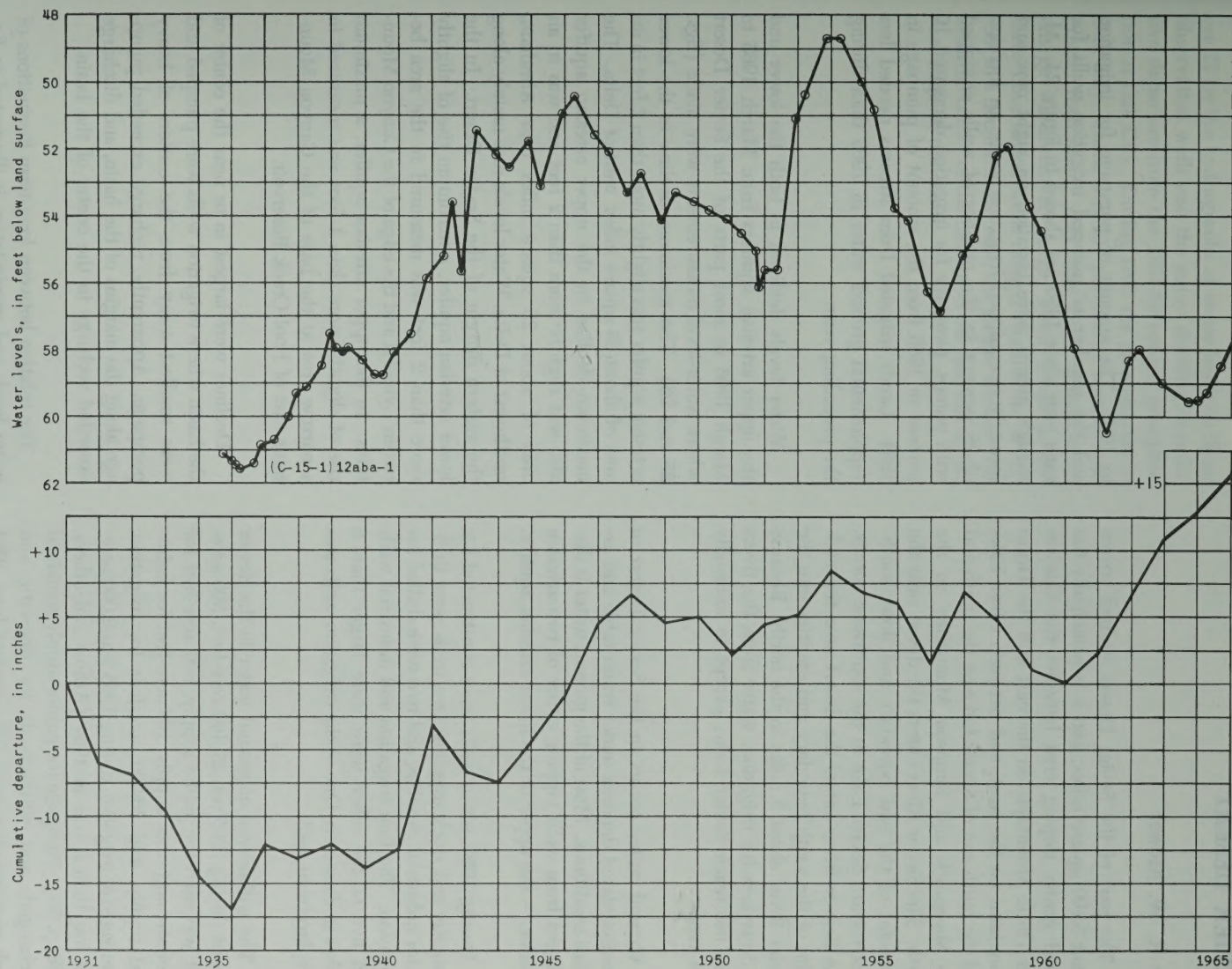


Figure 23.—Continued.

SEVIER DESERT

By R. W. Mower

The part of the Sevier Desert studied covers about 3,100 square miles; and it is principally the broad gently sloping area between the Canyon and Tintic Mountains on the east and the Drum Mountains on the west, and between Clear Lake and the north end of Sevier Lake on the south and the Sheeprock and Simpson Mountains on the north. The Sevier River enters the desert near the midpoint of the east boundary and flows southwest toward Sevier Lake in the southwest corner. The Beaver River enters the desert near the midpoint of the south boundary and empties into the Sevier River about 5 miles to the north. Because of diversions for irrigation, water from the rivers does not reach Sevier Lake, except in unusually wet years.

Ground water occurs in the Sevier Desert in unconsolidated deposits under water-table and artesian conditions. Most of the ground water is discharged from wells tapping either of two artesian aquifers — the upper or the lower artesian aquifer.

During 1965, seven wells were constructed for domestic and stock supplies; two wells were drilled for industrial supplies, and two were drilled for irrigation. The four irrigation and industrial wells and five of the other wells were larger than 6 inches in diameter. One of the irrigation wells was a replacement well.

The withdrawal of ground water in the Sevier Desert during 1965 was 27,400 acre-feet; 500 acre-feet was used for public supply, 800 acre-feet for domestic and stock supply, 100 acre-feet for industrial supply, and 26,000 acre-feet for irrigation. Pumpage for irrigation during 1965 was 3,000 acre-feet less than it was in 1964 (Arnow and others, 1965, p. 56). Pumpage for public supply remained unchanged, and withdrawals for domestic and stock purposes decreased 200 acre-feet from 1964

to 1965. The amount of pumpage for irrigation and the number of pumped irrigation wells for each year since 1950 are shown in figure 24. Although pumps were installed on eight new and formerly unequipped irrigation wells, an increase of 28 percent in the number of wells equipped with pumps, pumpage for irrigation decreased 10 percent in 1965 from the amount of pumpage in 1964. Lands irrigated from streams needed less supplemental ground water in 1965 than during the preceding year.

Water levels declined in both the lower and the upper artesian aquifers from March 1965 to March 1966 in most parts of the Sevier Desert where water-level measurements were made (figs. 25 and 26). The maximum decline in the lower artesian aquifer was slightly more than 2 feet in an area of about 65 square miles, west of Delta. The maximum decline in the upper artesian aquifer also was slightly more than 2 feet and was in an area of about 25 square miles near Abraham, northwest of Delta. Water levels rose mainly along the eastern margin of the Sevier Desert. In the lower artesian aquifer, a maximum rise of slightly more than 2 feet was measured in the area between Lynndyl and the edge of the Canyon Mountains. In the upper artesian aquifer, a maximum rise of slightly more than 1 foot was measured in a narrow area at the base of the Canyon Mountains east of Fool Creek Reservoir.

Declines were largest in or near the center of the basin where irrigation wells were pumped and were smallest away from the centers of heavy pumpage. Apparently, recharge exceeded pumpage along the margins of the basin, and discharge exceeded recharge in the center of the basin.

The relation between long-term fluctuations of water levels and precipitation is illustrated in fig-

ure 27 by the hydrographs of water levels in three observation wells and the curve showing cumulative departure from the 1931-60 normal precipitation at Oak City. During 1965 the precipitation at Oak City, which was 127 percent of normal, was greater than in any year since 1947. Although recharge was relatively large, water levels in the three observation wells ranged from a rise of 0.6 foot to a decline of 0.8 foot; the largest decline was near the center of the basin and the rise was at the east edge of the basin.

Figure 27—Graph showing relation of water levels in three observation wells and cumulative departure from 1931-60 normal precipitation at Oak City, 1965.

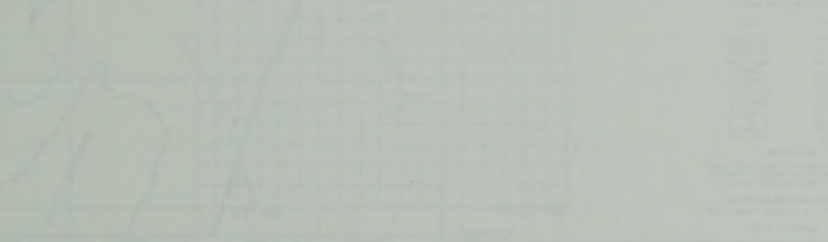


Figure 28—Map of part of the Davis Desert, showing change of water levels in three observation wells and cumulative departure from 1931-60 normal precipitation at Oak City, 1965.

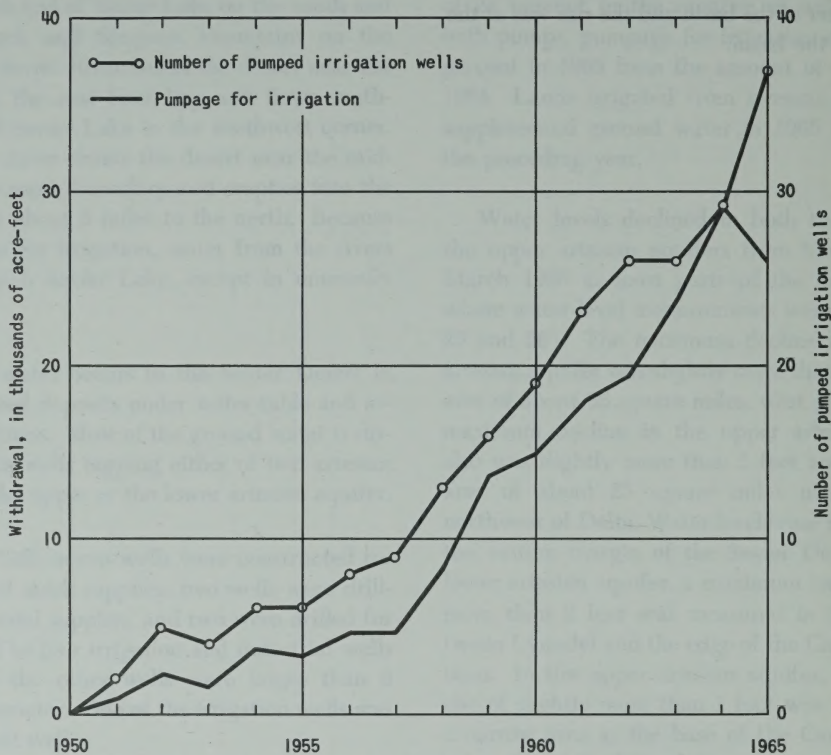


Figure 24.—Graph showing relation of number of pumped irrigation wells to pumpage for irrigation in the Sevier Desert, 1950-65.

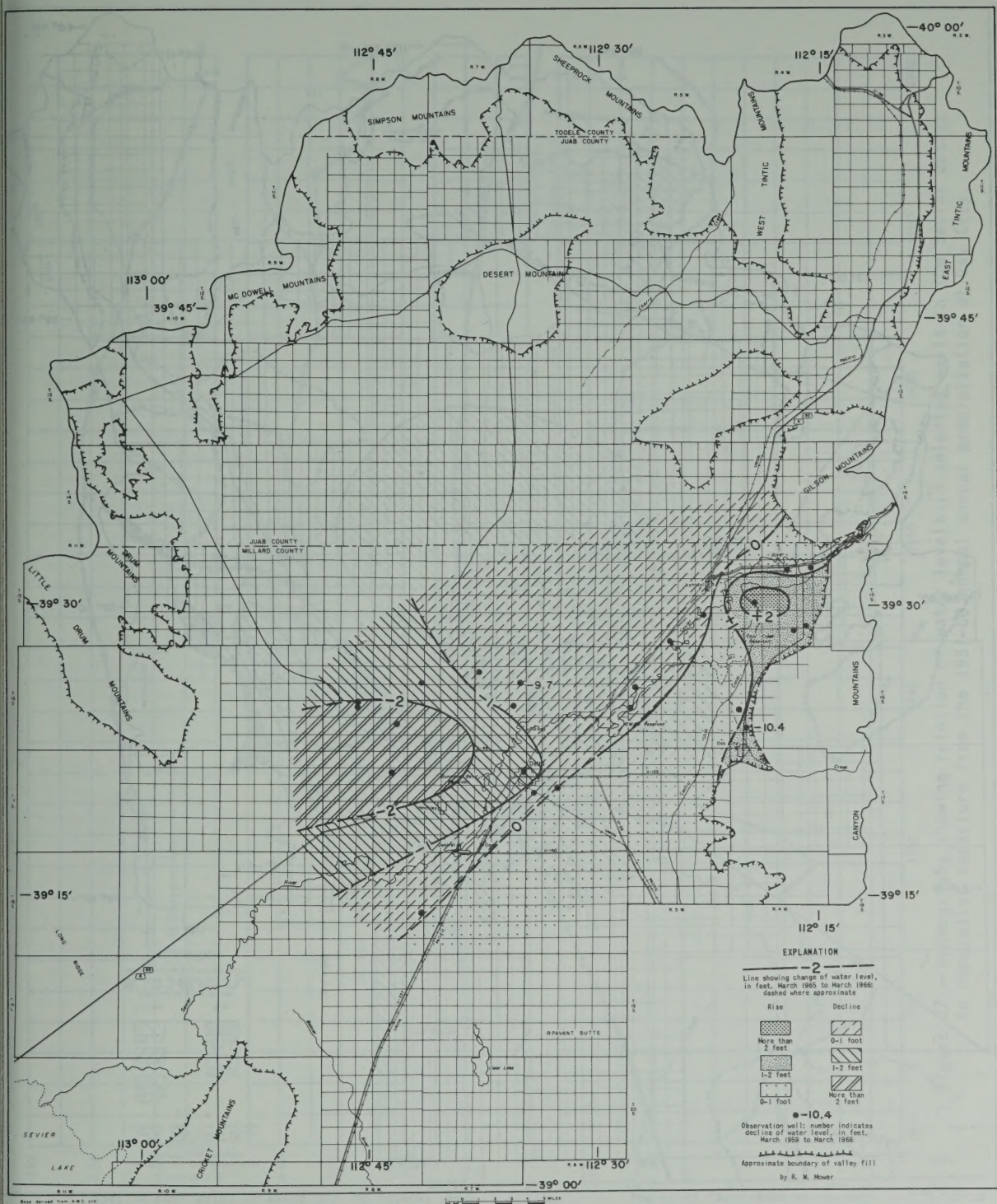


Figure 25.—Map of part of the Sevier Desert showing change of water levels in the lower artesian aquifer, March 1965 to March 1966.

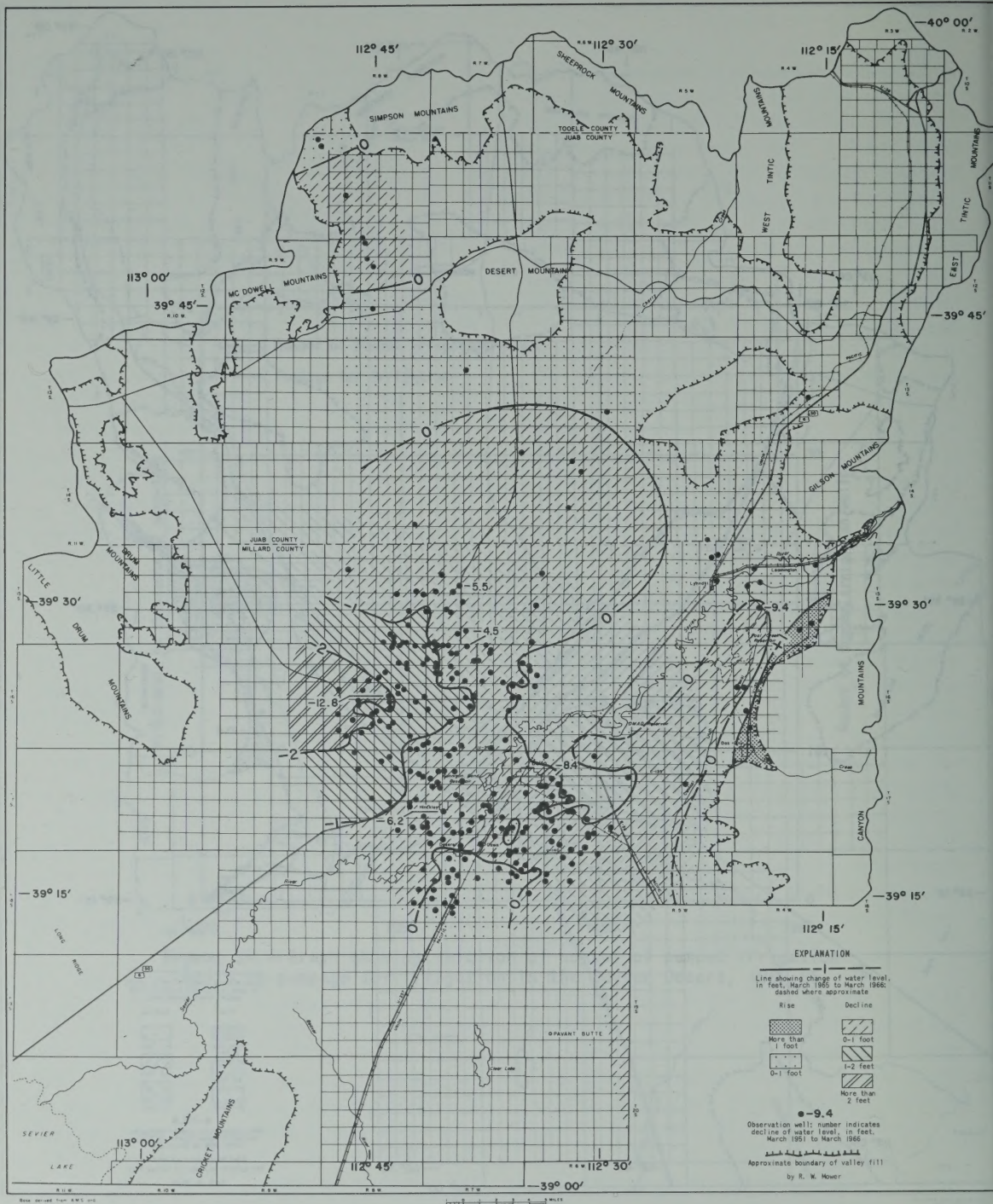


Figure 26.—Map of part of the Sevier Desert showing change of water levels in the upper artesian aquifer, March 1965 to March 1966.

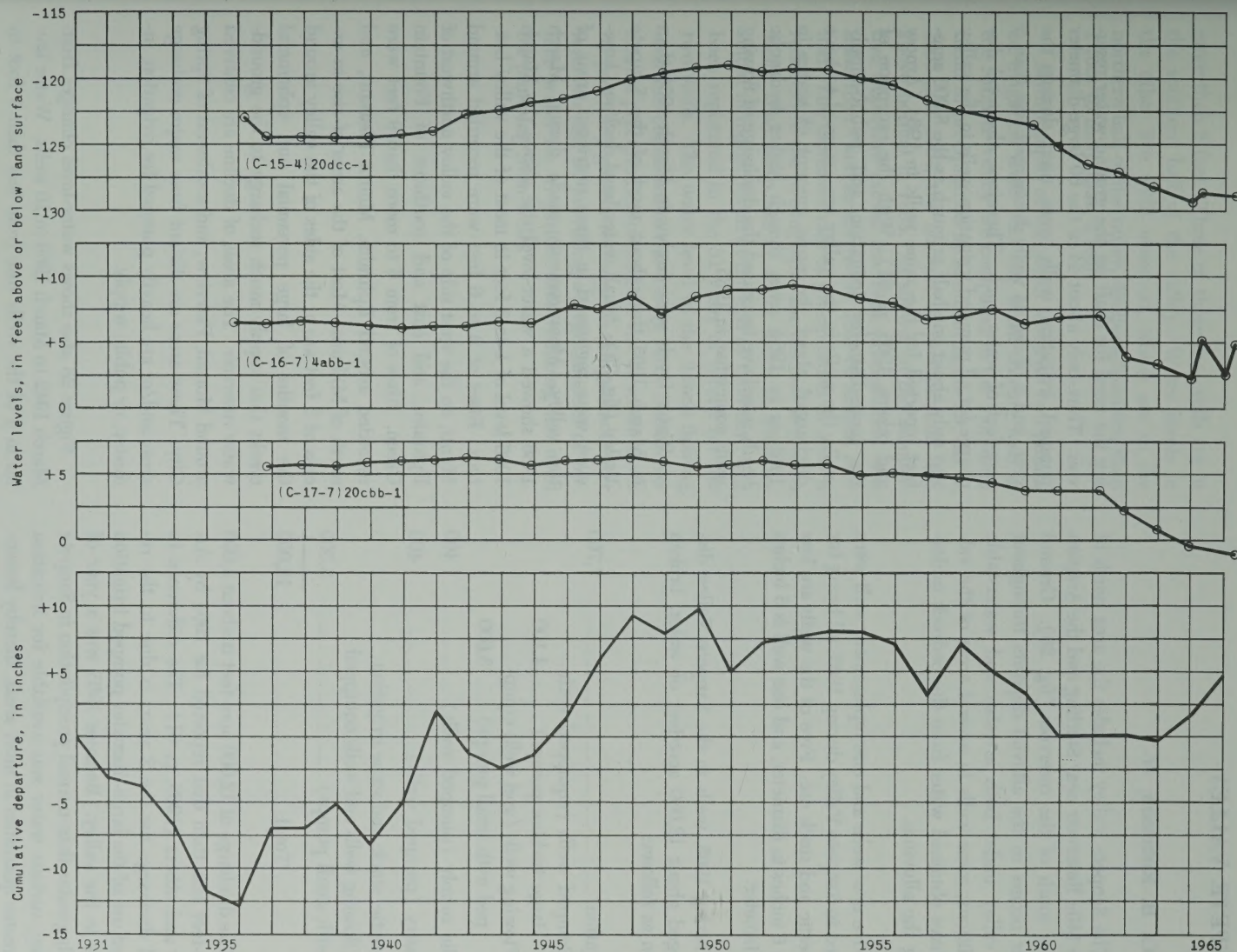


Figure 27.—Hydrographs showing relation of water levels in selected wells in the Sevier Desert to cumulative departure from the 1931-60 normal annual precipitation at Oak City.

SANPETE VALLEY

By G. B. Robinson, Jr.

The Sanpete Valley includes the area north of Nine Mile Reservoir near Sterling and the Arapien Valley south of the reservoir (fig. 28). Ground water occurs in the alluvial deposits throughout the valley under both artesian and water-table conditions; some wells in several areas of the valley have obtained water from the bedrock underlying the alluvium.

Five new wells and one replacement well were drilled in Sanpete Valley during 1965, all being for domestic and stock use. Five of the wells are less than 6 inches in diameter, and one well is 6 inches in diameter.

During 1965, wells in the Sanpete Valley discharged about 12,000 acre-feet of water, broken down as follows:

Irrigation	7,700
Pumped wells (equipped with large turbine pumps)	4,100
Flowing wells (and wells equip- ped with small pumps)	3,600
Public supply (pumped wells)	400
Industry (pumped wells)	400
Domestic, stock, and some irrigation (flowing wells and wells equipped with small pumps)	3,500
Total.....	12,000

The discharge of 12,000 acre-feet is about 4,000 acre-feet less than that reported for 1964 by Arnow and others (1965, p. 61). The difference in total discharge for the 2 years is due to the reduced use of the large-diameter pumped irrigation wells in the valley. Because 1965 was a year of much greater-than-normal precipitation in Sanpete Valley, surface water was available for irrigation in greater quantities in most areas, thereby lessen-

ing the need for draft on the ground-water reservoir. Thus, only about 44 of the 60 large-diameter pumped irrigation wells were used during the year, and 5 of the 44 wells discharged less than 5 acre-feet of water each. Therefore, the total discharge for all pumped irrigation wells in the valley was only about one-half as much as the 8,000 acre-feet reported for the same wells in 1964 (Arnow and others, 1965, p. 61). With the exception of the large-diameter irrigation and public-supply wells, the wells in the valley are assumed to have discharged about the same amount of water in 1965 as in 1964, even though higher hydraulic heads may have increased the discharge of flowing wells somewhat in 1965.

Water levels were higher in March 1966 than in March 1965 throughout most of the Sanpete Valley (fig. 28). Small water-level declines, however, were registered in three restricted areas of the valley. Measurements made during March 1966 showed a water-level rise above the March 1965 level of 1 to 3 feet in most of the valley bottom. Rises of 3 to 6 feet were recorded around Manti, on the west side of the valley northwest of Ephraim, and east and southeast of Fountain Green. Rises of from 6 to more than 9 feet were recorded around Ephraim, Mount Pleasant, and north of Milburn. Most of the areas of rise in excess of 3 feet are at the sides of the valley around the mouths of large perennial and ephemeral creeks that supply much recharge to the ground-water reservoir. The areas of decline are centered around Moroni, Fairview, and southwest of Spring City. These areas are distant from major recharge areas and/or are heavily pumped for irrigation, industry, or public supply.

Figure 28 also shows water-level changes from March 1942 to March 1966 in 10 wells. Water levels in 5 of the wells rose from less than 1 foot to

more than 5 feet. Three of these five wells are in the southern half of the valley. Water levels in the other five wells observed, which are in the northern half of the valley, declined from less than 1 foot to more than 2 feet.

Hydrographs of the water levels in two pumped irrigation wells and one small flowing well in the Sanpete Valley are compared to the long-term trend in precipitation at Manti in figure 29. As in 1963 and 1964, the amount of precipitation was above normal in 1965. As shown on the cumulative departure curve, the 1965 precipitation was more than 7 inches above the 1931-60 annual normal. The increased rate of precipitation in 1965 is reflected in the hydrographs for the two irrigation wells. The steep rise of water levels in 1965 resulted in higher levels at the end of 1965 than had been registered in the 31 years of record for the two wells. The water level in the 2-inch flowing well also continued to rise during 1965. The above-normal precipitation caused the rise of water levels by providing greater recharge to the ground-water reservoir and by providing a larger amount of surface water for irrigation, thus reducing the need for pumping from wells.

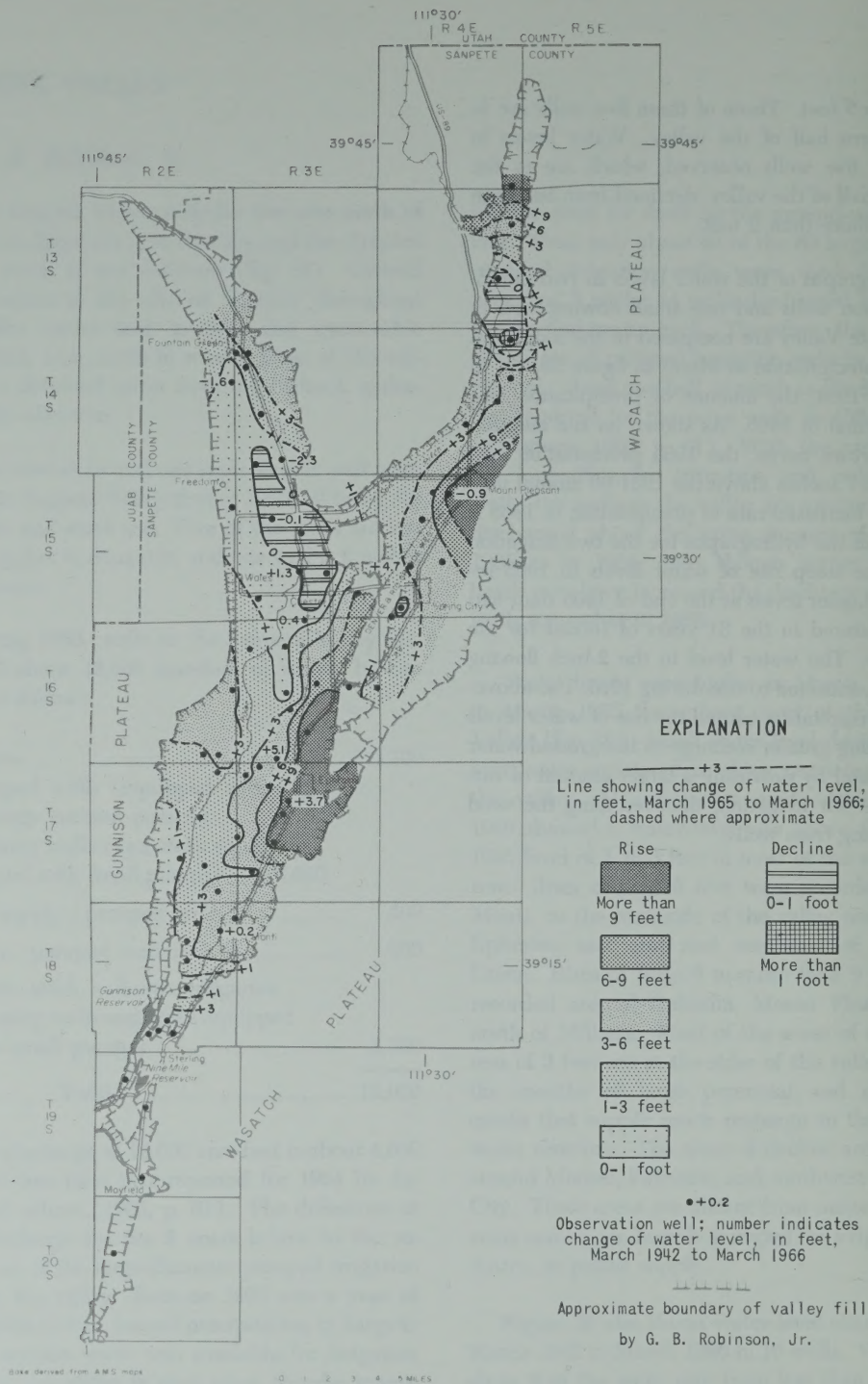


Figure 28.—Map of Sanpete Valley showing change of water levels, March 1965 to March 1966.

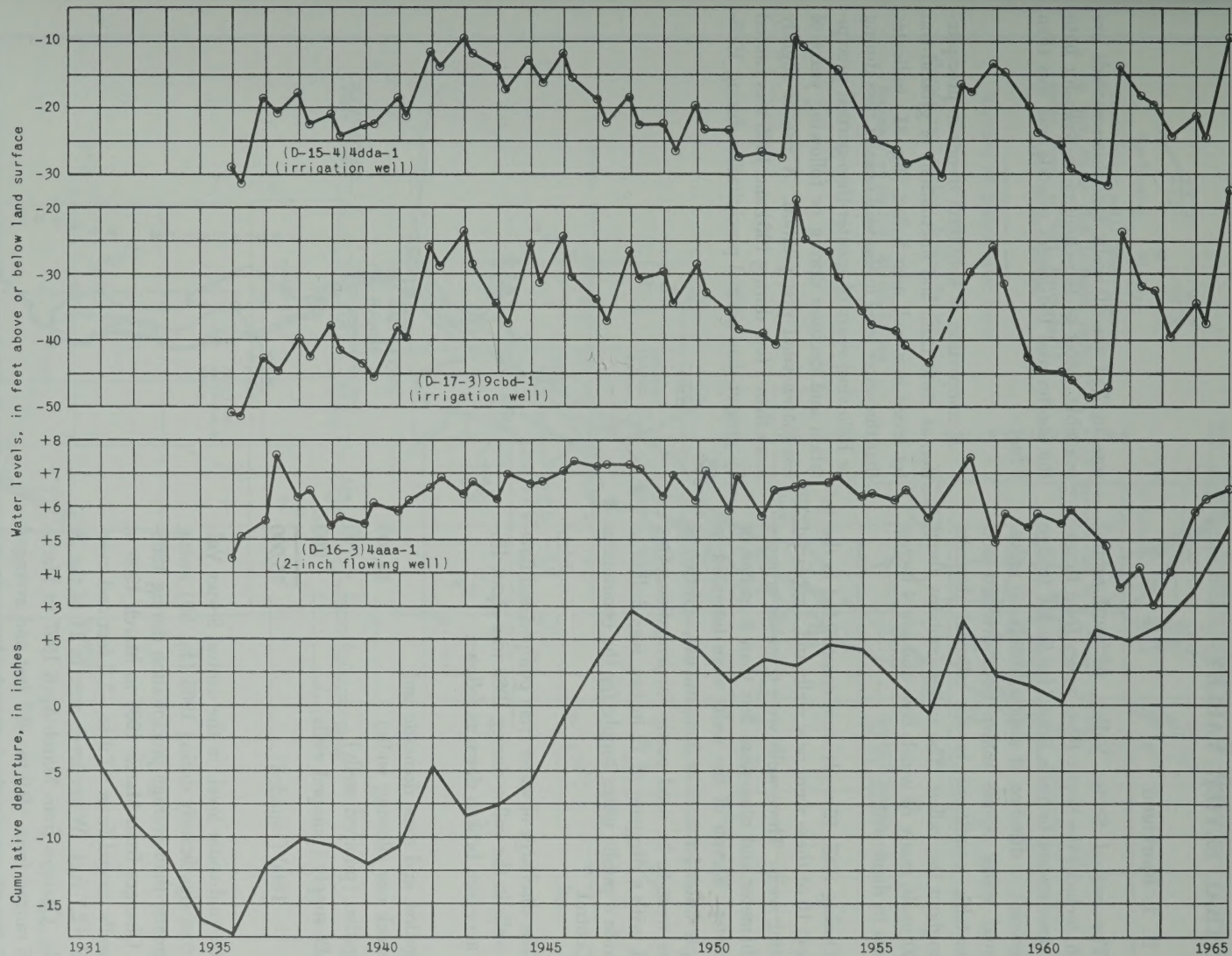


Figure 29.—Hydrographs showing relation of water levels in three wells in the Sanpete Valley to cumulative departure from the 1931-60 normal annual precipitation at Manti.

CENTRAL SEVIER VALLEY

By L. J. Bjorklund

The central Sevier Valley, in south-central Utah, includes the Sevier River valley from Kingston downstream to Yuba Dam (for Sevier Bridge Reservoir), a distance of approximately 90 miles. Ground water occurs under both artesian and water-table conditions in the alluvial deposits throughout the valley. The valley contains about 1,300 wells, many of which flow and are 4 inches or less in diameter.

During 1965, 12 wells were constructed in the valley; 10 of these were new wells and 2 replaced existing wells. Three wells were 6 inches or more in diameter and nine were less than 6 inches in diameter. Eleven of the wells were intended to supply water for stock or domestic use, and two of these were to be used partly for irrigation. One well, with a diameter of 12 inches, was drilled to provide a public water supply for the community of Central.

The discharge of water from pumped and flowing wells in the valley during 1965 was about 15,000 acre-feet, broken down as follows:

Irrigation, and some domestic and stock use (flowing wells)	14,000
Irrigation (pumped wells)	700
Public supply (pumped wells)	200
Total (rounded).....	<u>15,000</u>

Ground-water levels in the central Sevier Valley rose significantly during 1965 (fig. 30) owing to greater-than-average precipitation during 1963-65. Changes from March 1965 to March 1966 in 12 wells ranged from +7.9 to -1.5 feet and averaged +2.7 feet. Water levels rose in 11 of the 12 wells. Changes from March-April 1957 to March 1966 ranged from +9.0 to -3.7 feet and averaged +1.7 feet. Water levels during the longer period

rose in 7 of the 10 wells for which records are available. Most of the changes in wells for both the shorter and the longer periods was less than 3 feet.

A comparison of long-term trends in precipitation at Piute Dam and fluctuations of ground-water levels in a well near Salina (fig. 31) indicates that the water level in the well usually rises during or following years of greater-than-normal precipitation and declines during or following years of less-than-normal precipitation. A rise of slightly more than 1 foot during 1964 and 1965 was caused by greater-than-normal precipitation during 1963-65.

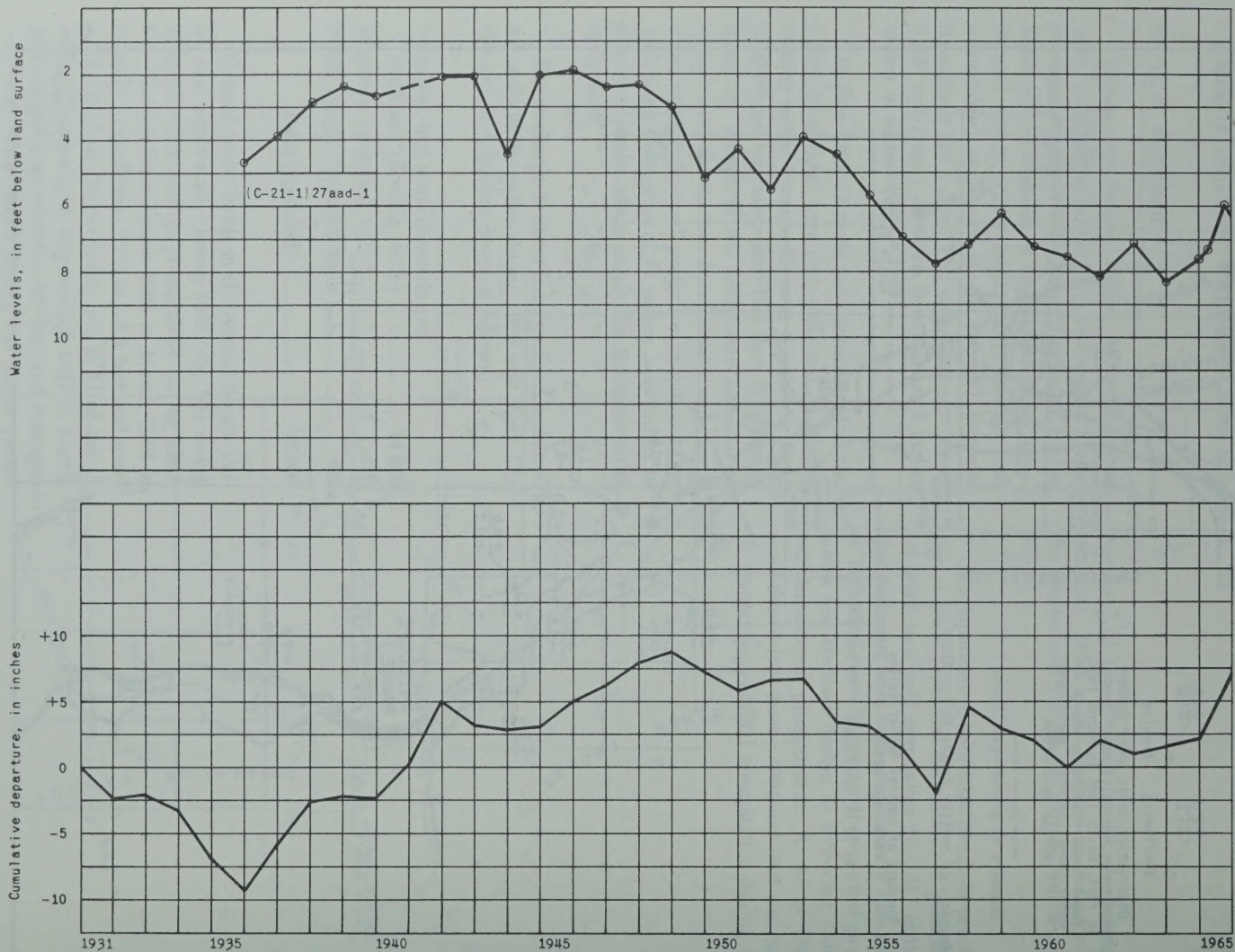


Figure 31.—Hydrograph showing relation of water levels in well (C-21-1)27aad-1 near Salina to cumulative departure from the 1931-60 normal annual precipitation at Piute Dam.

UPPER SEVIER VALLEYS

By G. B. Robinson, Jr.

The upper Sevier Valleys consist of Panguitch, Circle, East Fork, and Grass Valleys (fig. 32). Most of the available ground water in the valleys occurs in the alluvial deposits under either artesian or water-table conditions.

Seven new wells were completed in the upper Sevier Valleys during 1965, 4 being less than 6 inches in diameter and 3 being 6 inches or more. All four wells less than 6 inches in diameter were drilled for stock watering. One 6-inch well was drilled for stock, one was for domestic use, and one 10-inch well was drilled for public supply.

During 1965, wells in the upper Sevier Valleys discharged about 2,600 acre-feet of water, or about 800 acre-feet less than that reported for 1964 by Arnow and others (1965, p. 70). Total discharge for the 2 years differs because the irrigation well in Circle Valley, which is the only pumped irrigation well in the upper Sevier Valleys, was not used during 1965. This well was not used because of the increased surface-water supply for irrigation resulting from above-normal precipitation during the year. Thus, the 1,300 acre-feet of ground water used for irrigation during 1965 was entirely from flowing wells. These and the other wells in the area produced about the same amount of water as that reported for the last several years (Arnow and others, 1964, 1965). The discharge, in acre-feet, from wells in the four main valleys is broken down as follows:

	Domestic and stock	In- dustry	Irri- gation	Public supply	Total
Panguitch Valley ..	5	0	0	40	45
Circle Valley	10	3	0	70	83
East Fork Valley ..	5	0	0	40	45
Grass Valley	1,100	0	1,300	0	2,400
Total (rounded) ..	1,120	3	1,300	150	2,600

Water levels in March 1966 in the upper Sevier Valleys generally were higher than in March 1965 (fig. 32). Water levels in 16 of 21 wells observed

rose by amounts ranging from less than 1 foot to more than 14 feet; four wells showed small declines, and one well showed no change. Substantial water-level rises were registered in central Panguitch Valley, Circle Valley, and the Johns Valley segment of East Fork Valley; these rises are believed to be due to increased ground-water recharge during 1965. The small declines are not significant and are believed to be due to local conditions. Figure 32 also shows the water-level changes between March 1961 and March 1966 in 14 selected observation wells. The net change was a general rise in water levels throughout the area, with the exception of northern Grass Valley. Water levels in 12 of 14 wells showed rises ranging from about one-half foot to almost 12 feet. Two wells at the northern end of Grass Valley showed declines of about 1½ feet.

The long-term relations between fluctuations of water levels in Panguitch Valley, the average annual discharge of the Sevier River at Hatch, and the annual fluctuations of precipitation at Panguitch are shown in figure 33. A comparison of the well hydrograph and the river hydrograph shows close correlation in annual fluctuations. This correlation demonstrates the close relationship of ground water to surface water in the area — that is, they are interdependent along the river system. A comparison of either hydrograph with the cumulative-departure curve shows a similar correlation in annual fluctuations. Thus, in general, the water levels and the stream discharge in the area fluctuate directly in response to variations in the amount of precipitation. During 1965, precipitation in the upper Sevier Valleys was considerably greater than normal, as shown by the steep rise of the cumulative-departure curve. In like manner, the water level in well (C-34-5)8adb-2 rose steeply in response to the resultant recharge to the ground-water reservoir.

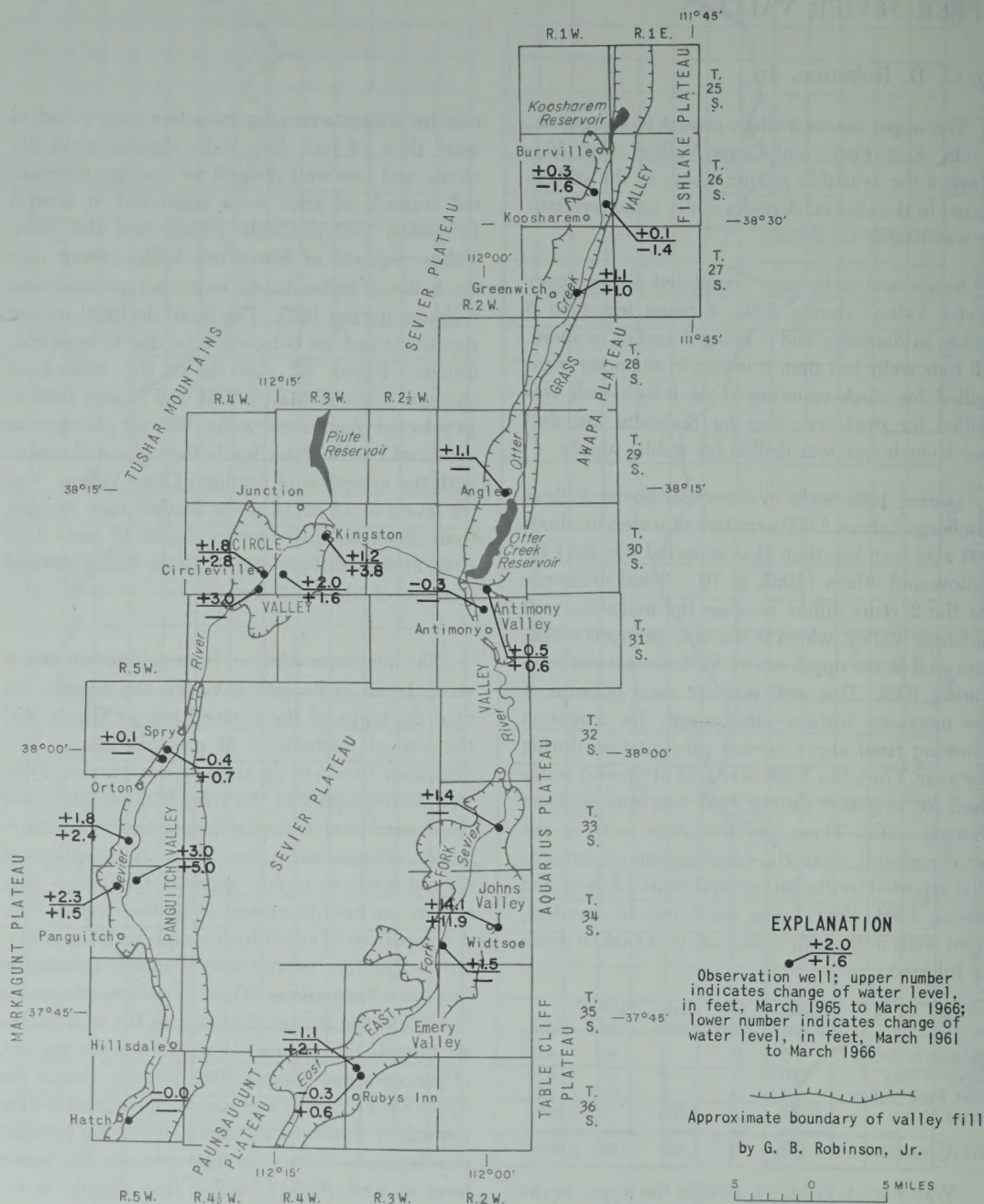


Figure 32.—Map of the upper Sevier River valleys showing changes of water levels, March 1965 to March 1966 and March 1961 to March 1966.

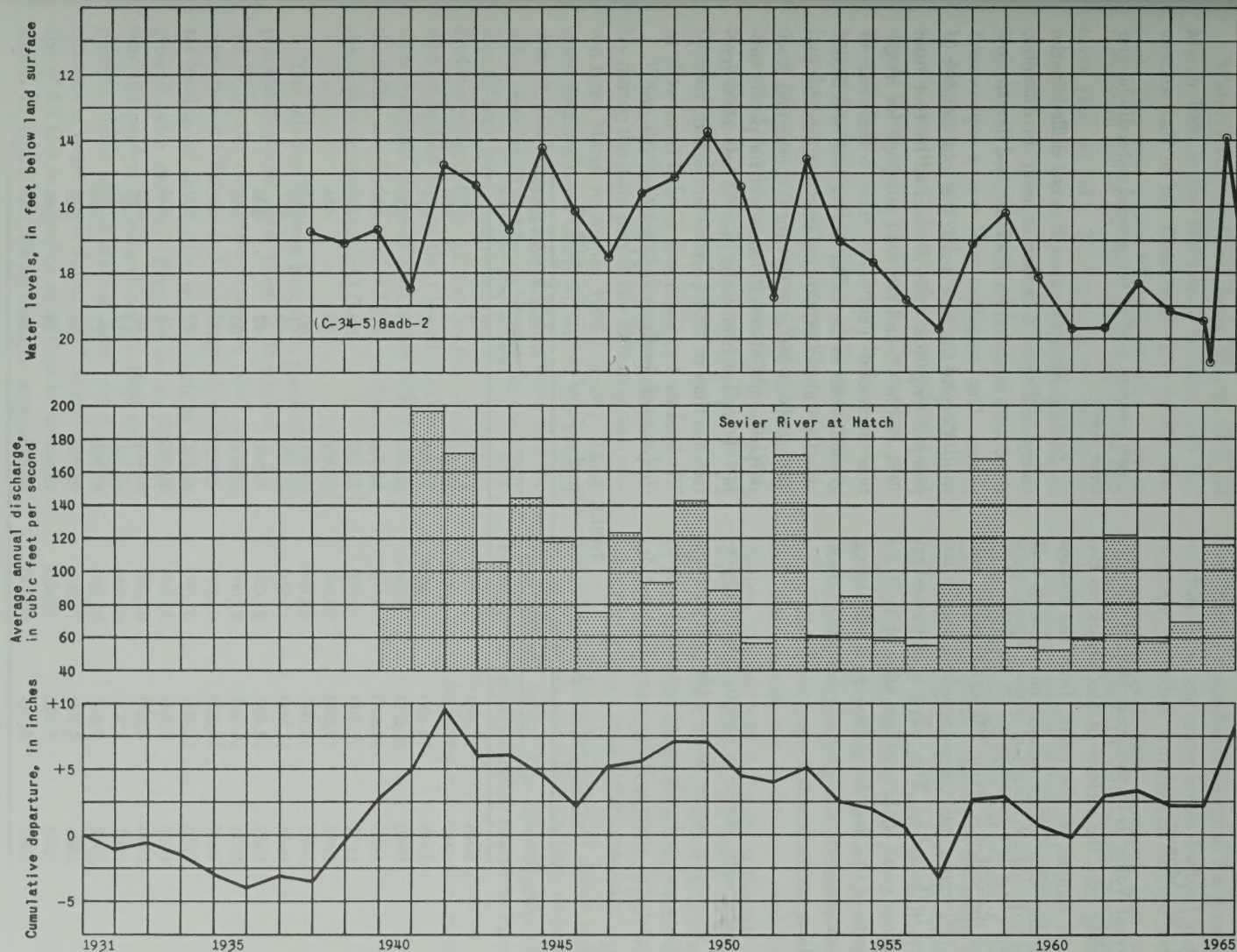


Figure 33.— Hydrograph showing relation of water levels in well (C-34-5)8adb-2 near Panguitch and average annual discharge of the Sevier River at Hatch to cumulative departure from the 1931-60 normal annual precipitation at Panguitch.

PAVANT VALLEY

By R. W. Mower

Pavant Valley is in southeast Millard County, extending from the vicinity of McCornick on the north to Kanosh on the south, from the Pavant Range and Canyon Mountains on the east and northeast to a low basalt ridge on the west. The area of the valley is about 300 square miles, and about 500 square miles of mountainous terrain are drained to the valley. The valley is undrained on the surface south of the southern edge of T. 20 S.; and north of this line the surface is an undulating plain covered with sand dunes, from which there is little or no surface drainage.

Ground water occurs in unconsolidated deposits in the valley under water-table and artesian conditions and in basalt under water-table conditions. Artesian aquifers in the unconsolidated de-

posits provide most of the ground water discharged from wells.

During 1965, seven wells were drilled in the valley. All were 6 inches or more in diameter; three were intended for stock use, and four for irrigation. One irrigation well was a replacement well. Despite the new wells, the total number of pumped irrigation wells diminished by four from 1964 (table 4), and the total pumpage for irrigation decreased (fig. 34). The withdrawal of ground water in the valley during 1965 was 68,800 acre-feet: about 68,300 acre-feet was used for irrigation, about 350 acre-feet for domestic and stock purposes, and about 150 acre-feet for public supply. Pumpage from wells in 1965 was 3,900 acre-feet less than in 1964 (Arnow and others, 1965, p. 73) because less water was needed from wells to supplement irrigation supplies from streams.

TABLE 4.
Discharge from wells (estimated) and number of wells in Pavant Valley, 1946-65

Year	Discharge (acre-feet)			Number of pumped irrigation wells	Total number of wells in valley
	Flowing wells	Pumped wells	Total		
1946	17,300	400	17,700	3	343
1947	17,400	1,000	18,400	5	349
1948	19,400	1,200	20,600	5	351
1949	18,600	2,200	20,800	8	367
1950	17,600	5,100	22,700	20	400
1951	16,500	9,800	26,300	33	413
1952	16,600	10,800	27,400	39	424
1953	18,700	15,100	33,800	46	445
1954	17,500	17,900	35,400	45	451
1955	14,400	21,600	36,000	49	466
1956	11,000	27,000	38,000	56	485
1957	10,200	32,300	42,500	65	498
1958	10,000	37,000	47,000	73	507
1959	6,300	53,300	59,600	101	522
1960	5,900	61,400	67,300	110	532
1961	4,500	61,800	66,300	113	535
1962	3,600	58,200	61,800	117	540
1963	2,700	77,000	79,700	133	542
1964	2,500	70,000	72,500	133	548
1965	2,700	66,100	68,800	129	555

Water levels declined from March 1965 to March 1966 in the McCornick, Kanosh, and the western half of the Greenwood and Pavant districts; they rose in the Flowell, Meadow, and in the eastern half of the Greenwood and Pavant districts (see fig. 35). The average net change in water level in the valley was a rise of 0.5 foot, in contrast to an average decline of 1.2 feet, observed from March 1964 to 1965.

Maximum observed declines amounted to slightly more than 2 feet in the Pavant district and nearly 2 feet in the McCornick, Greenwood, and Kanosh districts. The maximum declines were in areas where pumped irrigation wells were concentrated, in areas somewhat removed from recharge, or in areas of little recharge. Water levels rose because of the above-normal precipitation in 1964-65, and good recharge conditions in the alluvial fans between Holden and Meadow.

Water levels declined throughout Pavant Valley during the main part of the 1965 irrigation season from March to August 1965 (fig. 36). Maximum declines were nearly 40 feet in the Flowell district, and between 10 and 20 feet in each of the other districts. The average decline in the valley was 6.7 feet, but in individual districts the average declines ranged from 3.2 feet in the Greenwood district to 12.3 feet in the Flowell district. More than one-third of the ground water withdrawn in the valley is withdrawn in the Flowell district, and the largest declines occurred there.

The relation between long-term fluctuations of precipitation and water levels is illustrated in figure 37 by the cumulative-departure curve for precipitation at Fillmore and a hydrograph of the water level in an observation well in each of the six ground-water districts. Precipitation at Fillmore was 124 percent of normal during 1964 and 115 percent above normal during 1965. As a result, changes in water levels during 1965 ranged from a rise of 2.3 feet to a decline of 1.7 feet in the wells shown in figure 37. These changes suggest that

withdrawals exceeded recharge in the ground-water districts where water levels declined and that recharge exceeded withdrawals in the districts where water levels rose, assuming that normal recharge is concurrent with normal precipitation.

The concentration of dissolved solids in ground water ranges widely in Pavant Valley. The lowest concentrations are near the east margin of the valley, as at well (C-23-5)5acd-1 in the southeastern part of the Meadow district, where the concentration is less than 500 ppm (parts per million); the highest concentrations are near the west margin, as at well (C-23-6)8abd-1 near the northwest edge of the center of pumping in the Kanosh district, where the concentration exceeds 3,500 ppm (fig. 38). The concentration of dissolved solids usually changes inversely with a change in the rate of recharge. Because recharge was above normal during 1964 and 1965, the concentration diminished in 1965 from what it had been 1 to 3 years earlier in all the wells sampled, except in well (C-23-6)8abd-1 (fig. 38). Well (C-23-6)8abd-1 is in an area removed from the effect of direct recharge and it discharges water that has been recirculated from irrigated fields. The concentration of dissolved solids in water from this well increased from 2,220 ppm in 1957 to 3,640 ppm in 1965. From 1964 to 1965 the concentration increased 110 ppm.

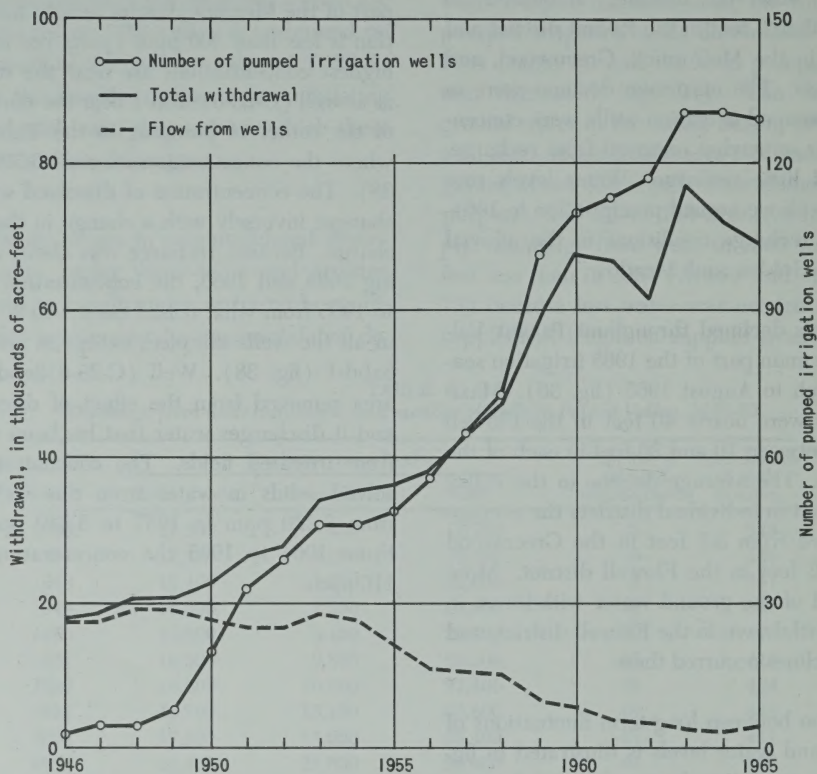


Figure 34.—Graph showing relation of number of pumped irrigation wells and total discharge to discharge from flowing wells in Pavant Valley, 1946-65.

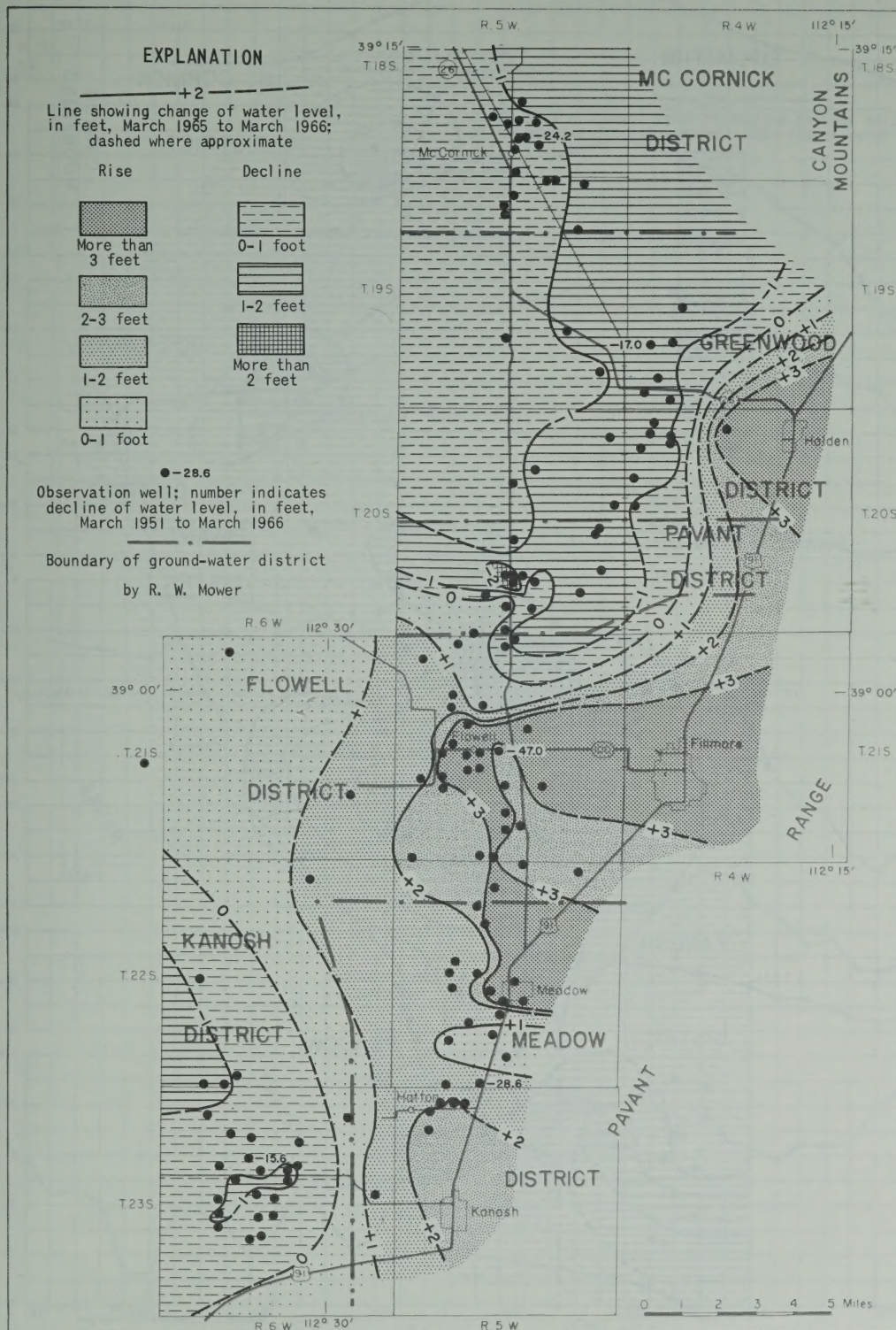


Figure 35.—Map of the Pavant Valley showing change of water levels from March 1965 to March 1966.

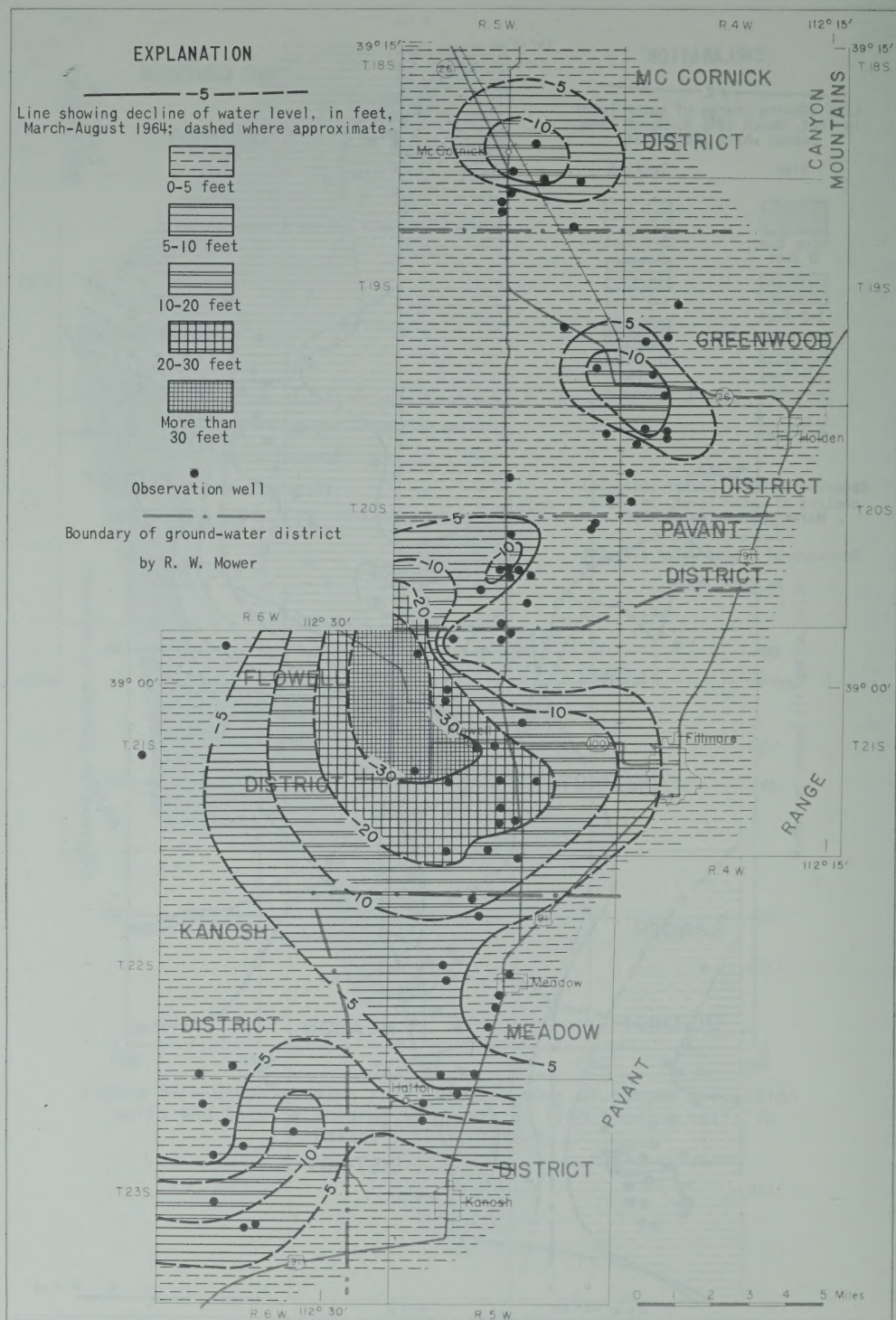


Figure 36.—Map of the Pavant Valley showing decline of water levels from March to August 1965.

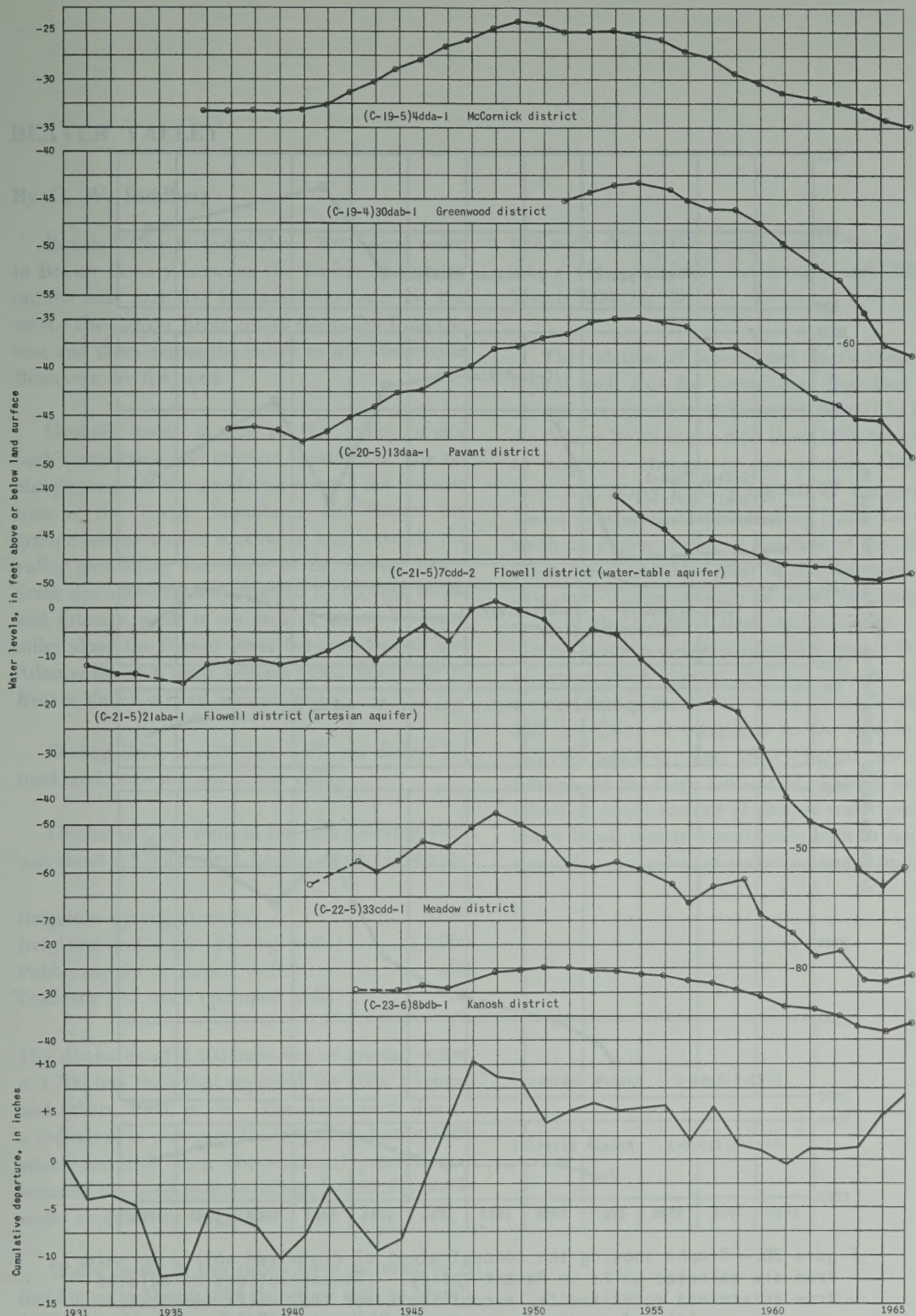


Figure 37.—Hydrographs showing relation of water levels in selected wells in Pavant Valley to cumulative departure from the 1931-60 normal annual precipitation at Fillmore.

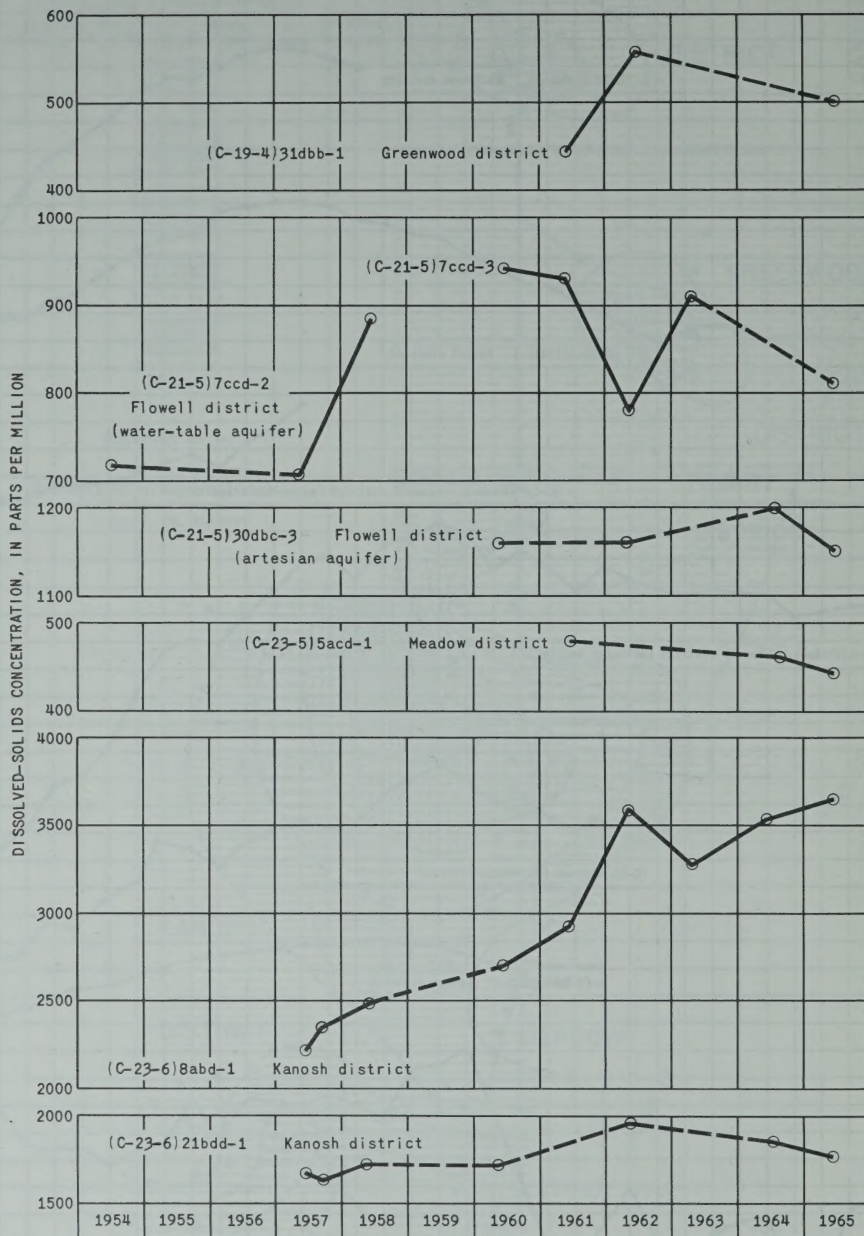


Figure 38.—Graphs showing the concentration of dissolved solids in water from six selected wells in Pavant Valley. (Concentrations calculated from determined constituents, except those for 1962 which were calculated from residue on evaporation at 180°C).

BEAVER VALLEY

By G. W. Sandberg

Beaver Valley includes about 200 square miles in Beaver County between the Tushar Mountains on the east and the Mineral Mountains on the west. The Beaver River enters the valley from the east and flows across the valley to the Minersville Reservoir on the west.

Ground water occurs in the valley under both water-table and artesian conditions. The recharge areas for the aquifers are along the western base of the Tushar Mountains, and thence the ground water moves southwest and through the valley paralleling the course of the Beaver River. Some ground water is discharged by springs, seeps, and artesian wells in an area of about 6 square miles along the Beaver River between Beaver and Adamsville, but most ground-water discharge in Beaver Valley is from pumped wells.

During 1965, one 10-inch well was drilled for stock and domestic use in the valley.

Discharge from wells in the valley during 1965 was about 4,400 acre-feet, broken down as follows:

Irrigation (pumped wells)	3,250
Irrigation and stock (flowing wells)	1,000
Public supply (pumped wells)	100
Domestic and stock (pumped wells)	50

The discharge of 4,400 acre-feet of ground water is 1,700 less than that reported for 1964 (Arnow and others, 1965, p. 79). The decrease is due to a reduction in pumpage for irrigation during 1965 which resulted when above-normal precipitation lessened the need to draw on supplemental ground-water supplies for irrigation.

Water levels in the valley were as much as 8 feet higher in March 1966 than they were in March 1965 (fig. 39). Water levels rose in all 12 observa-

tion wells during this period, and in 3 wells there was a net water-level rise from March 1950 to March 1966 (fig. 39).

The relation of water-level fluctuations in a typical well and the cumulative departure from normal precipitation at Beaver is shown in figure 40. Water levels in the well show little correlation to long-term changes in precipitation. Furthermore, the water level is highest in summer and lowest in winter. The controlling factor for water levels in Beaver Valley is the flow of the Beaver River which provides most of the water used for irrigation. Large amounts of water are spread on most of the irrigated land, and recharge to the ground-water reservoir is relatively great. The rise of water levels during 1965 was due to the increased flow of the Beaver River during 1965 (33,810 acre-feet) as compared to the flow in 1964 (25,700 acre-feet) and 1963 (19,950 acre-feet). Because of the large amount of recharge and the relatively small amount of ground water pumped, water levels remain consistently high in much of the valley regardless of variations in precipitation.

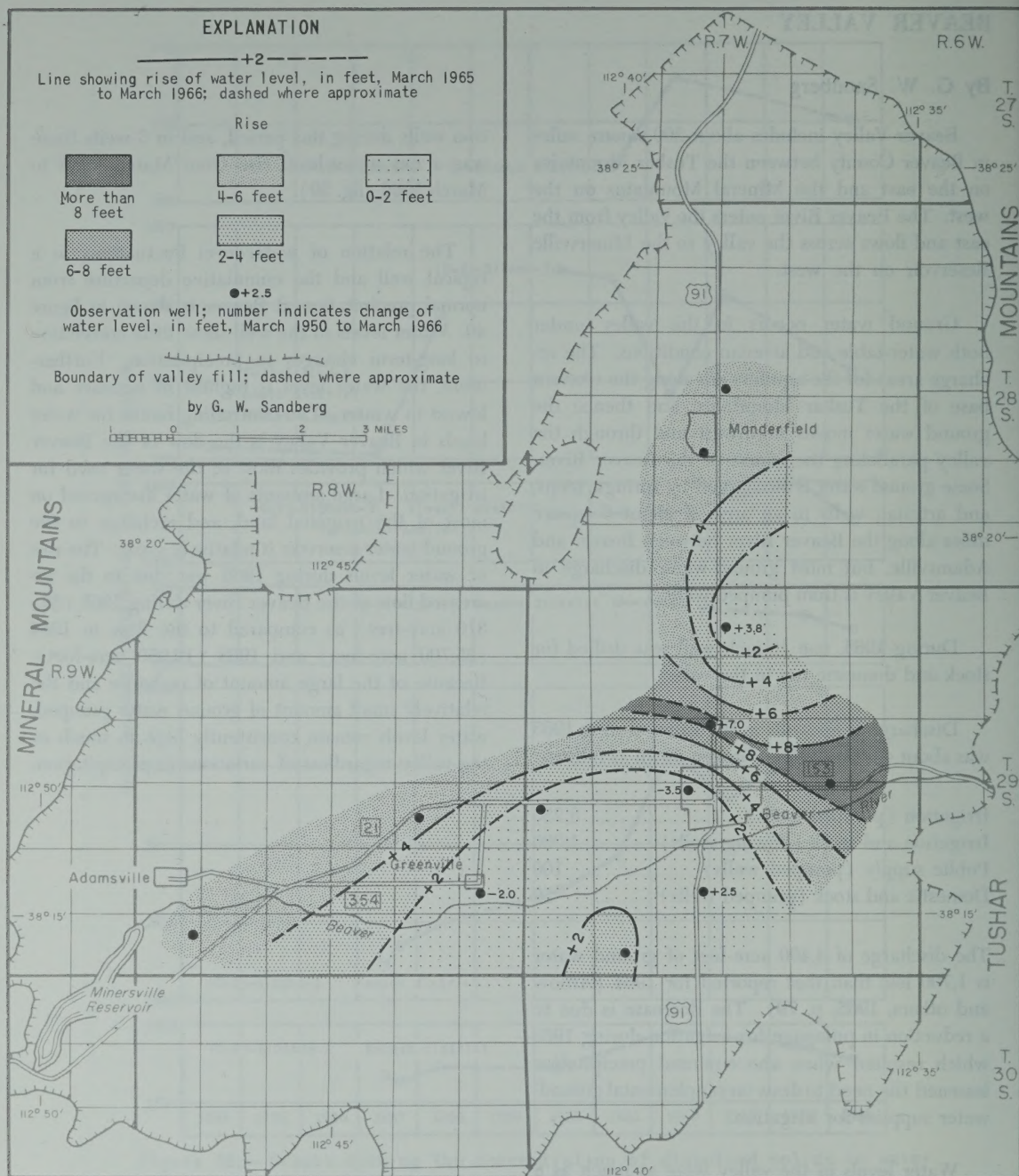


Figure 39.—Map of Beaver Valley showing change of water levels, March 1965 to March 1966.

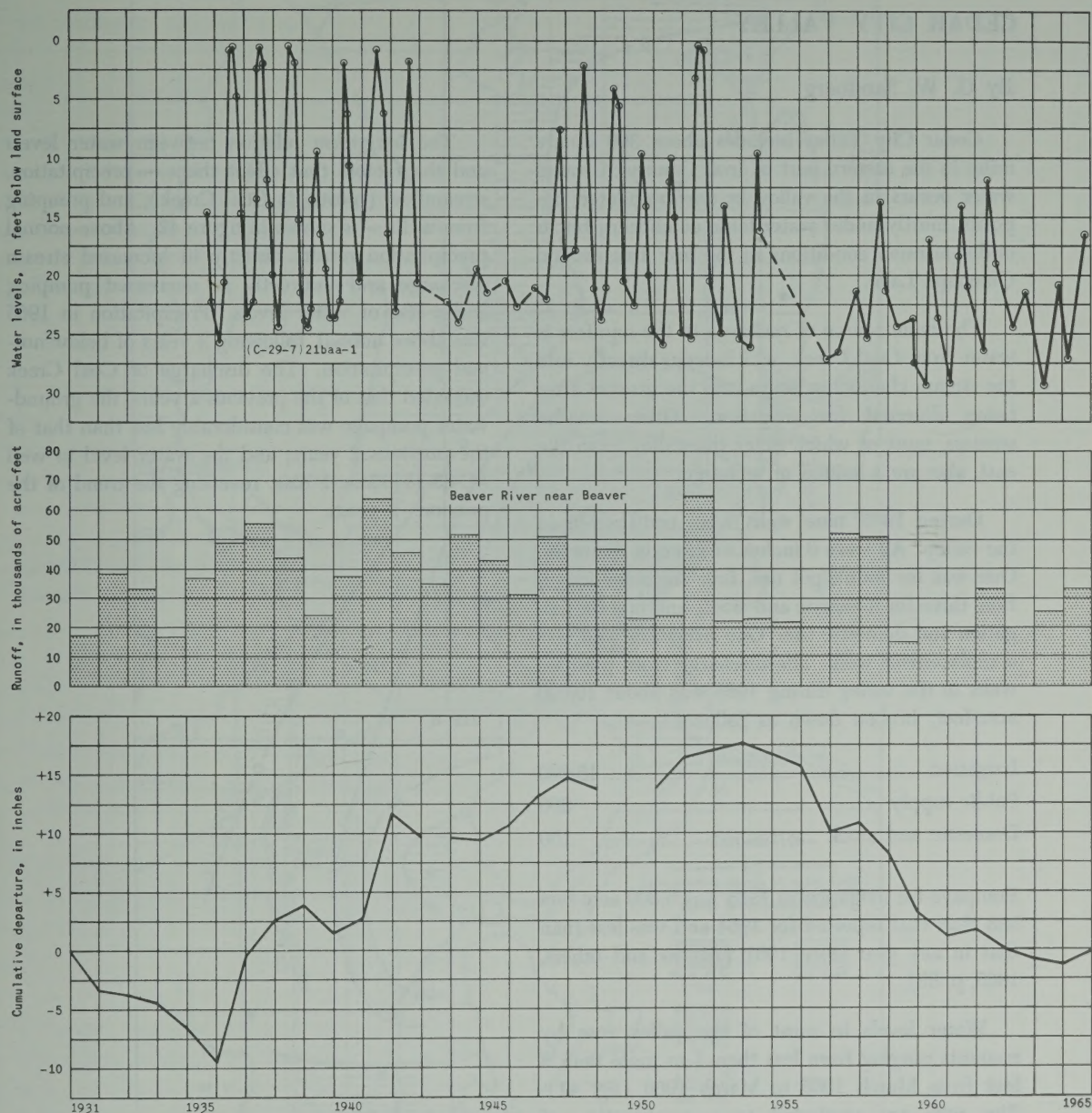


Figure 40.—Hydrograph showing relation of water levels in well (C-29-7)21baa-1 and the annual discharge of Beaver River near Beaver to the cumulative departure from the 1931-60 normal annual precipitation at Beaver.

CEDAR CITY VALLEY

By G. W. Sandberg

Cedar City Valley includes about 300 square miles in the eastern part of Iron County. Ground water occurs in the valley in unconsolidated deposits, mostly under water-table conditions; but is under artesian conditions in the low area around Quichapa Lake.

The main source of recharge to the aquifers is water from Coal Creek, which seeps directly into the stream channel or seeps into the ground after being diverted for irrigation. Other smaller streams, most of which enter the valley from the east, also are a source of recharge.

During 1965, nine wells were constructed in the valley. All were 6 inches or more in diameter. One was for municipal use, four were for irrigation, three for domestic and stock, and one for irrigation and domestic use. One irrigation well was a replacement well. The discharge from pumped wells in the valley during 1965 was about 16,000 acre-feet, broken down as follows:

Irrigation	15,600
Public supply	500
Domestic and stock	150

Pumpage for irrigation in 1965 was 5,600 acre-feet less than that reported for 1964 and was less than that in any year since 1961 (Arnow and others, 1965, p. 82).

Water levels in most of the valley rose by amounts ranging from less than 1 to more than 6 feet from March 1965 to March 1966 (fig. 41). The rises are attributed to a combination of above-normal recharge resulting from the above-normal precipitation and the decrease in pumping during the year (fig. 42). Water levels declined in those areas on the north, west, and south edges of the valley that are relatively distant from sources of recharge and contain a few large pumped wells.

The long-term relation between water levels and the factors that affect them — precipitation, streamflow (mostly in Coal Creek), and pumping from wells — is shown in figure 42. Above-normal precipitation results directly in increased stream discharge and indirectly in decreased pumping and a rise of water levels. Precipitation in 1965 was above normal, following 3 years of below-normal precipitation. The discharge of Coal Creek exceeded that of the previous 2 years, the ground-water pumpage was considerably less than that of the previous 2 years; and the water level in well (C-35-11)33aac-1 rose, reversing the trend of the previous 2 years.

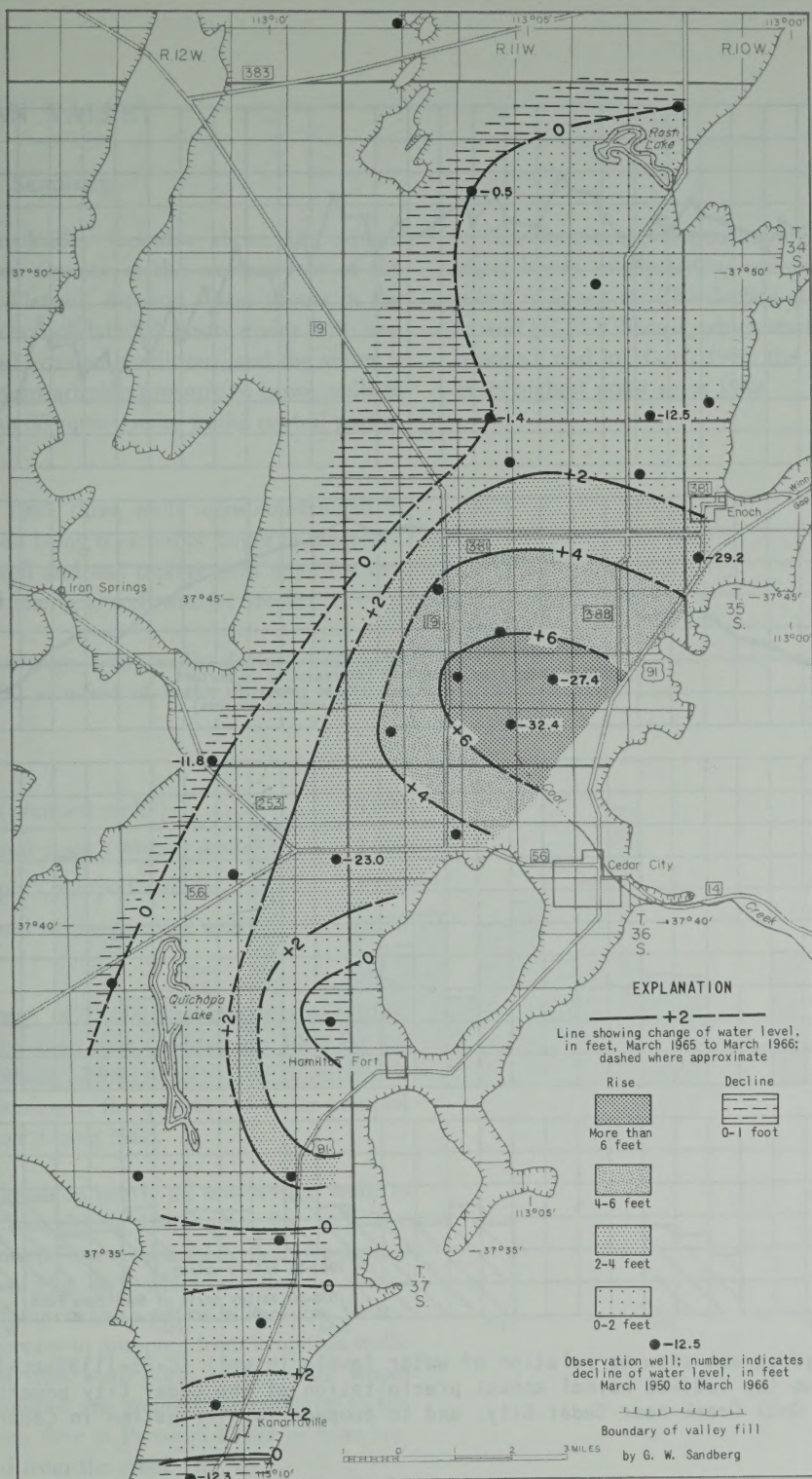


Figure 41.—Map of Cedar City Valley showing change of water levels, March 1965 to March 1966.

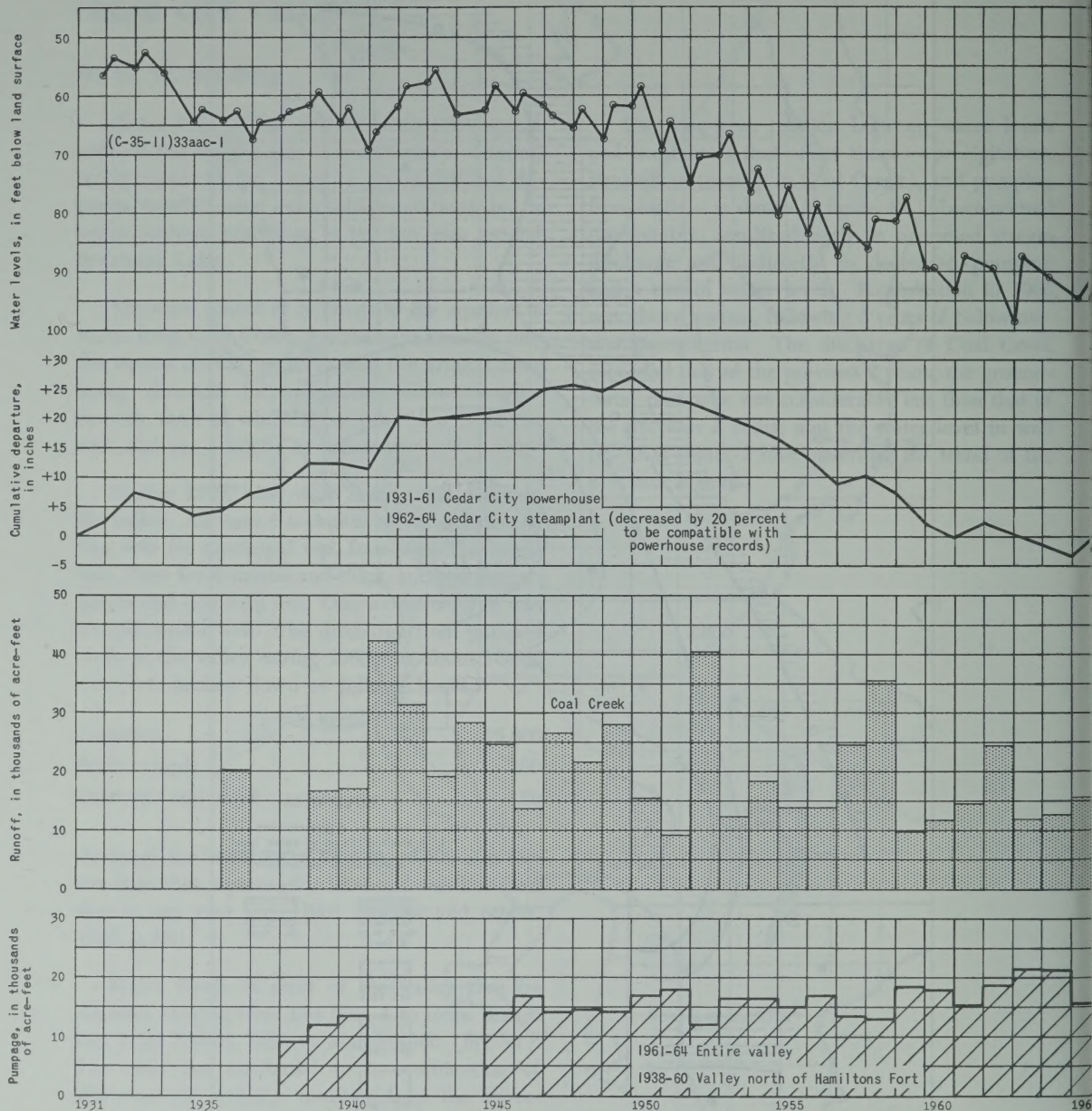


Figure 42.—Hydrograph showing relation of water levels in well (C-35-11)33aac-1 to cumulative departure from the 1931-60 normal annual precipitation at the Cedar City powerhouse, to the discharge of Coal Creek near Cedar City, and to pumpage for irrigation in Cedar City Valley.

PAROWAN VALLEY

By G. W. Sandberg

Parowan Valley includes about 150 square miles in Iron County at the western foot of the Markagunt Plateau. Ground water occurs in the valley in unconsolidated deposits under both water-table and artesian conditions, and the water is under sufficient artesian pressure to cause wells to flow in about 35 square miles in the central part of the valley.

During 1965, three wells were constructed in the valley, all being 6 inches or larger in diameter. One new well and one replacement were for irrigation, and one new well was for stock.

The discharge from wells during 1965 was about 15,000 acre-feet of water, broken down as follows:

Irrigation (pumped wells)	13,000
Irrigation and stock (flowing wells)	2,000
Public supply (pumped wells)	100
Domestic and stock (pumped wells)	150

The discharge of 15,000 acre-feet is about 1,000 acre-feet less than that reported for 1964 by Arnow and others (1965, p. 85). The difference is due to a decrease in the quantity of water pumped for irrigation during 1965.

Water levels in nearly all observation wells in the valley rose during 1965. (See fig. 43.) The rise was caused by a combination of above-normal precipitation (fig. 44), which resulted in above-normal recharge to the aquifers in Parowan Valley, and the decrease in pumping from irrigation wells. The largest rises were north of Parowan, where the opportunities are greatest for recharge to the aquifers from flow in Parowan Creek or from water diverted from the creek (fig. 43).

The long-term relation among fluctuations of water levels, precipitation, and pumpage is illustrated in figure 44. The decline of the water level in well (C-34-8)5bca-1, which started in 1949, was reversed; and in March 1966, the water level was at its highest point since 1959.

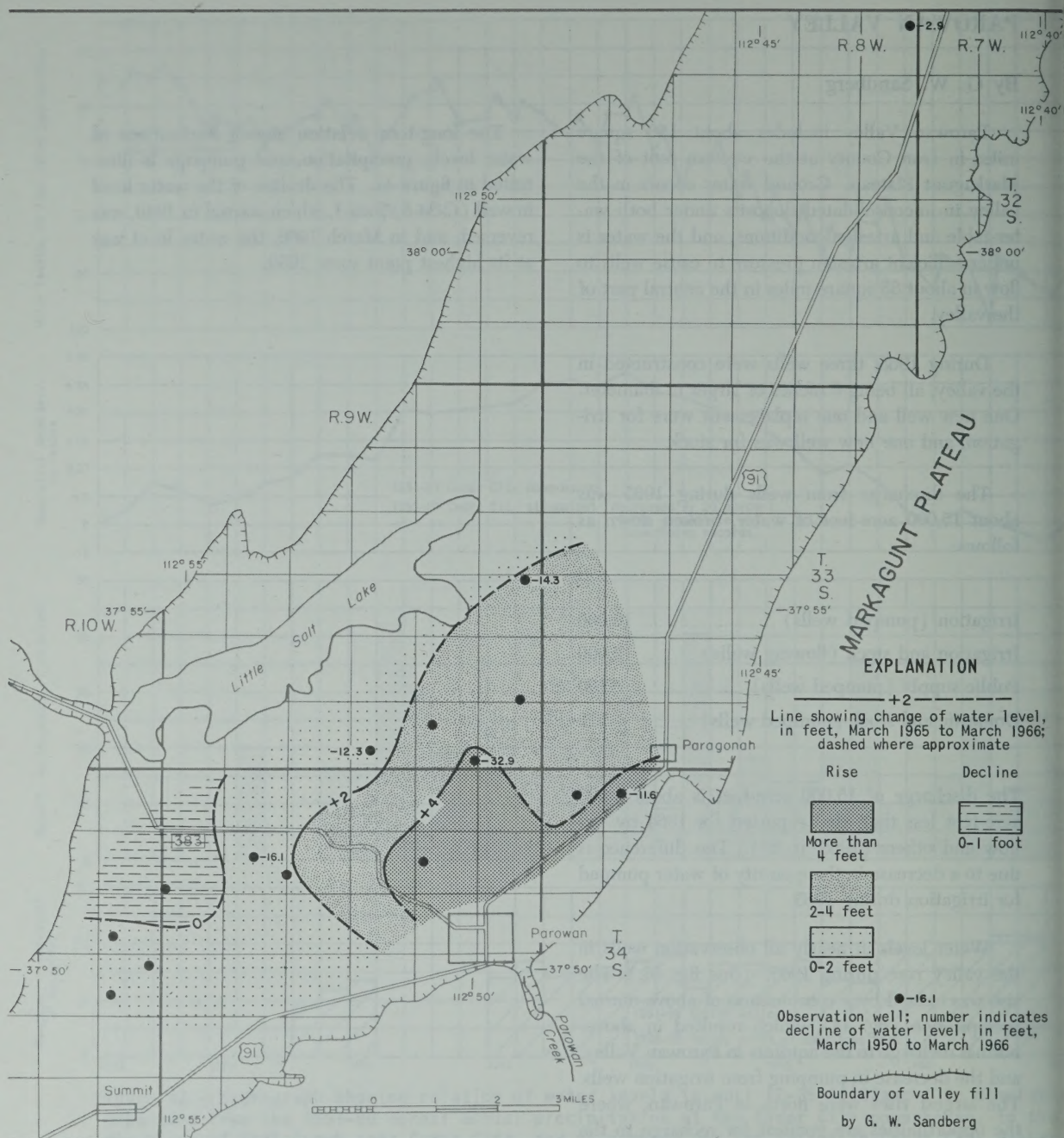


Figure 43.—Map of Parowan Valley showing change of water levels, March 1965 to March 1966.

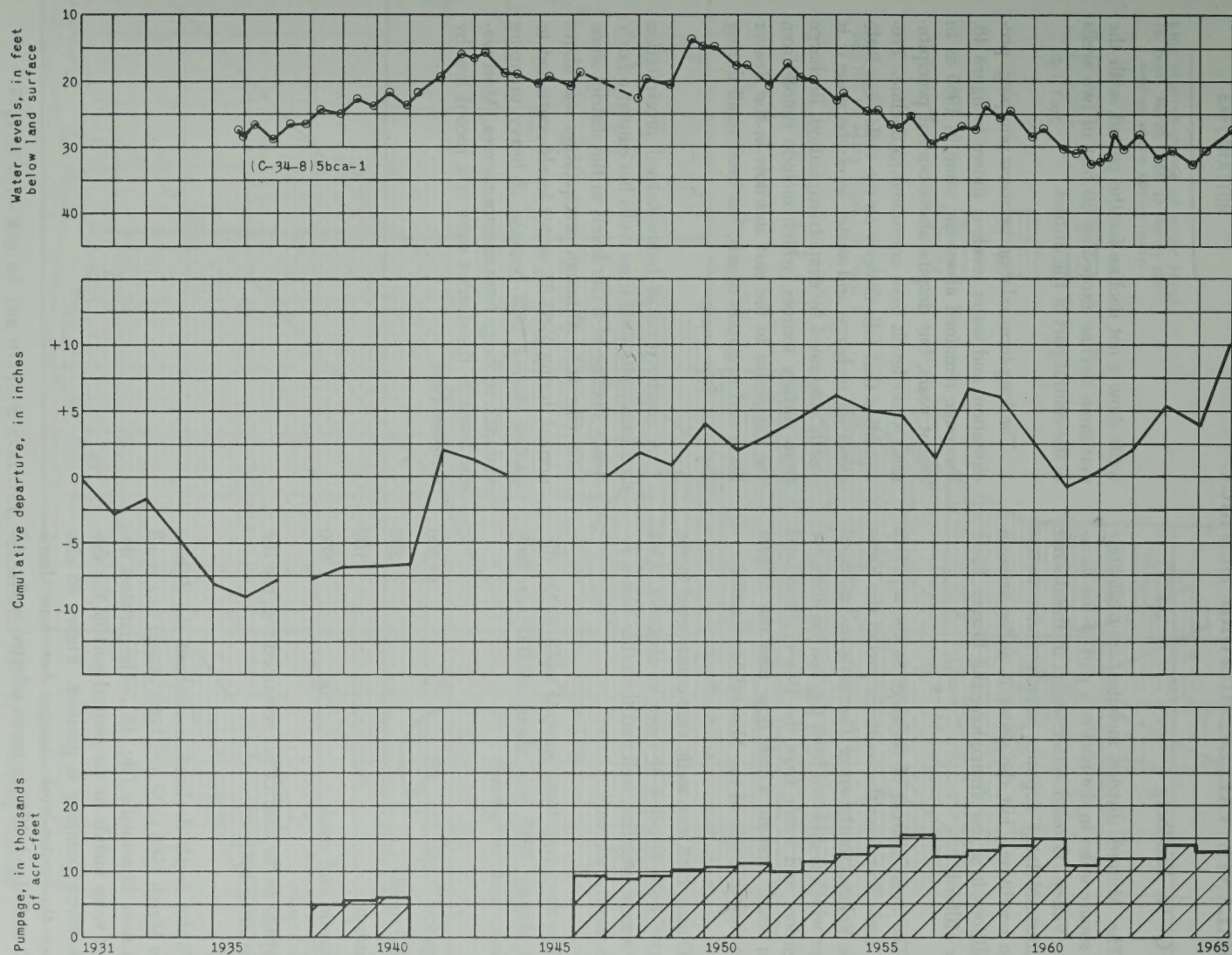


Figure 44.—Hydrograph showing relation of water levels in well (C-34-8)5bca-1 to cumulative departure from the 1931-60 normal annual precipitation at Parowan and to pumpage for irrigation in Parowan Valley.

ESCALANTE VALLEY, MILFORD DISTRICT

By G. W. Sandberg

The Milford district includes approximately 300 square miles in the northern part of the Escalante Valley. Ground water occurs in the district in unconsolidated deposits, mostly under water-table conditions; but the water is under artesian conditions in a few areas along the Beaver River near Milford.

The main sources of recharge to the aquifers are: underflow from the southern part of the Escalante Valley (southwest of Thermo); unconsumed water which is diverted from the Beaver River for irrigation; and losses from the Beaver River and from small streams which flow into the district from the west side of the Mineral Mountains.

During 1965, two wells were constructed in the district, both 6 inches or more in diameter. One was a new irrigation well and the other was a replacement stock well.

The discharge from pumped wells in the district during 1965 was about 44,000 acre-feet, broken down as follows:

Irrigation	43,500
Public supply	200
Industry	100
Domestic and stock	600

Pumpage in the district has remained roughly the same since 1961.

Water levels declined throughout the district from March 1965 to March 1966, except in a small area near Minersville (fig. 45). The greatest declines were mainly in the central part of the district, where pumping is greatest. Figure 45 also shows the water-level changes between March 1950 and March 1966 in seven selected wells. All

wells show a net decline for the period, with the maximum decline exceeding 30 feet in two wells in the central part of the district.

The long-term relation between pumping, precipitation, and water levels is shown in figure 46. Pumpage remained about the same in 1965 as in recent years, but despite above-normal precipitation, water levels have continued to decline. Precipitation that falls directly on the valley has little effect on recharge and water levels because it is mostly consumed by evapotranspiration. Recharge from surface sources, which include runoff from the mountains to the east and flow in the Beaver River and irrigation canals, has been small during the past few years.

A combination of below-normal precipitation and heavy pumping from wells has caused a fairly steady decline of water levels in the district since 1950 (fig. 46). Although precipitation was above normal during 1963-65, water levels continued to decline during 1965 because of heavy pumping and little recharge from surface sources. Most water levels in the district were at a record low by October 1965.

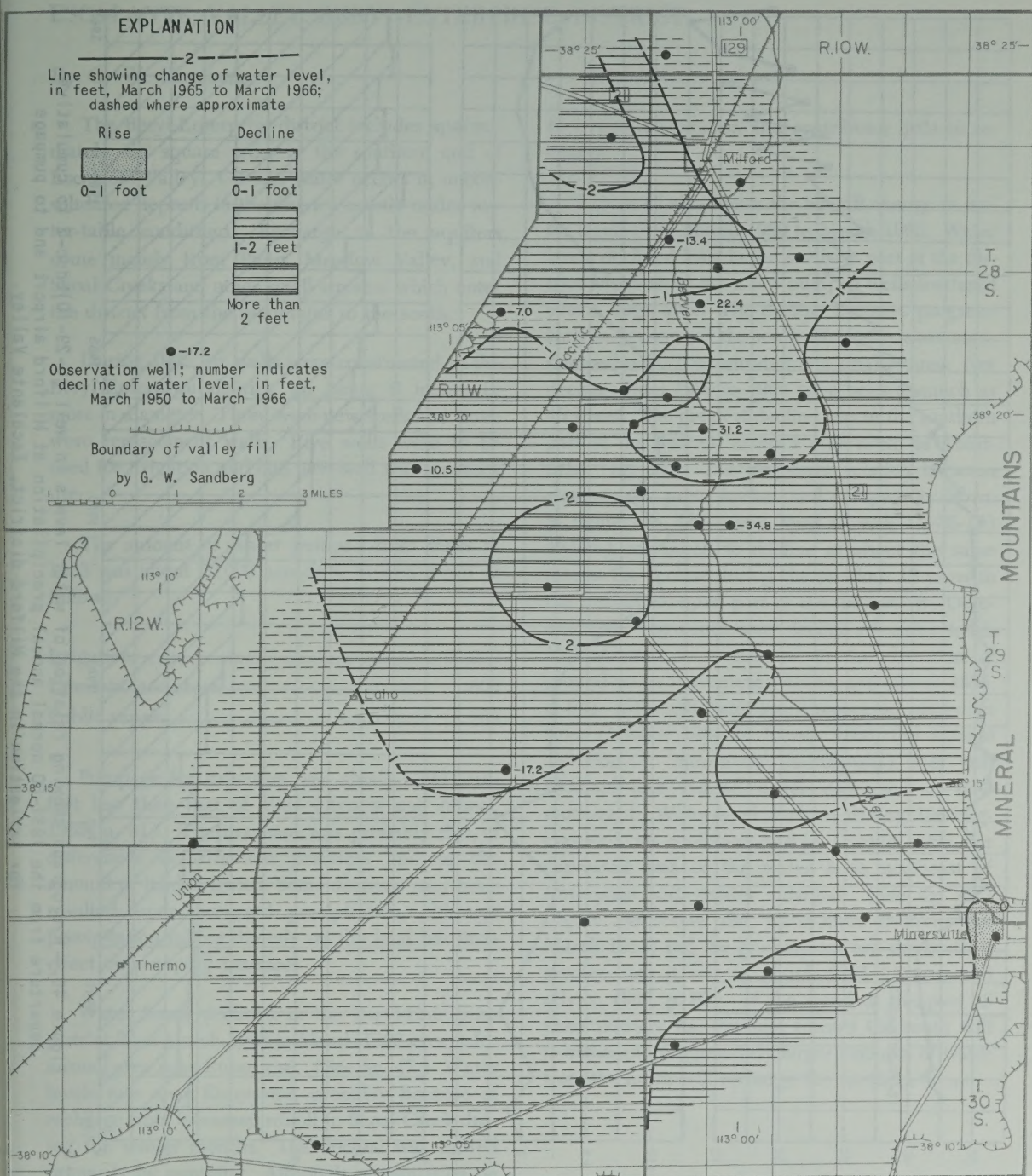


Figure 45.—Map of the Milford district, Escalante Valley, showing change of water levels, March 1965 to March 1966.

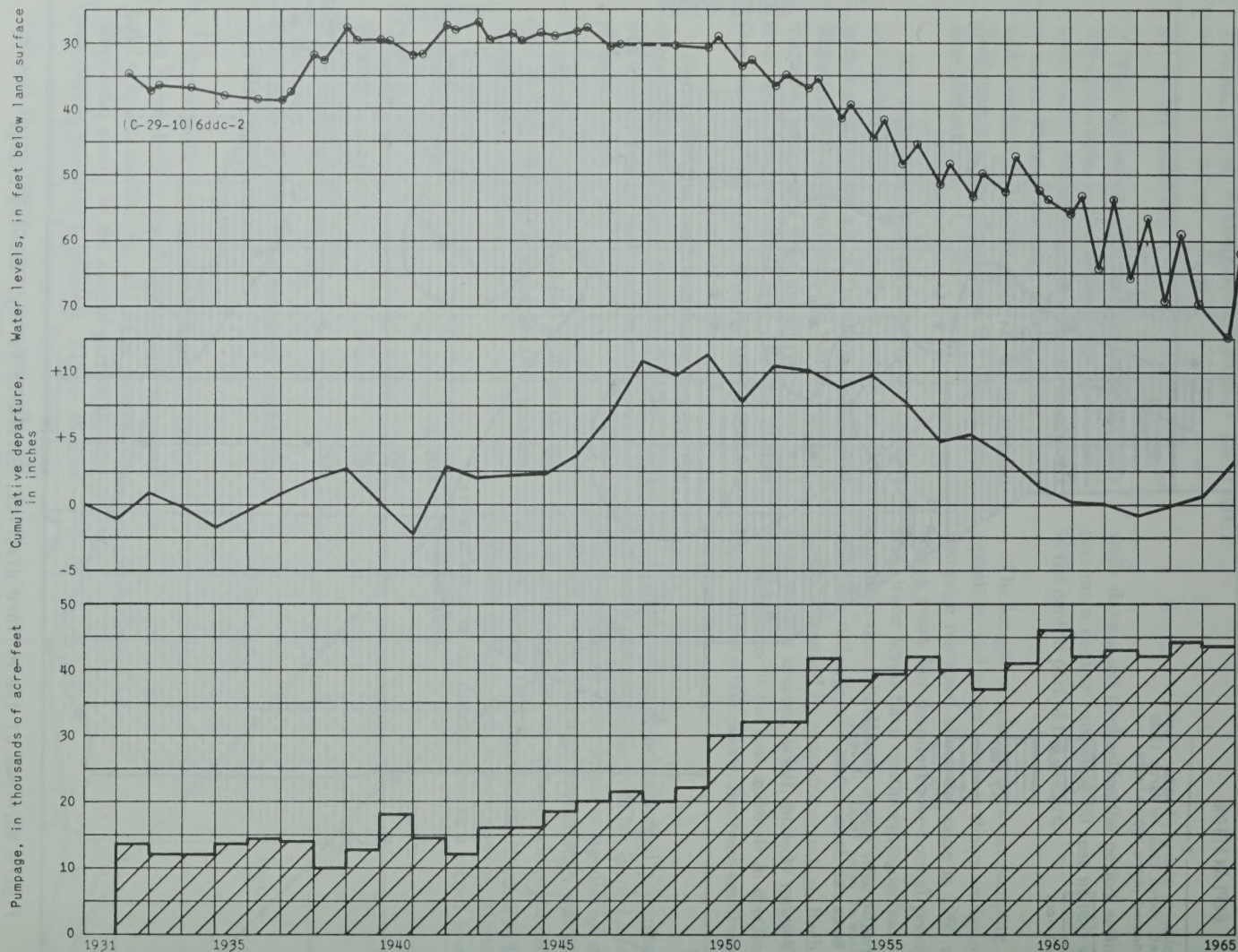


Figure 46.—Hydrograph showing relation of water levels in well (C-29-10)6ddc-2 to cumulative departure from the 1931-60 normal annual precipitation at Milford airport and to pumpage for irrigation in the Milford district, Escalante Valley.

ESCALANTE VALLEY, BERYL-ENTERPRISE DISTRICT

By G. W. Sandberg

The Beryl-Enterprise district includes approximately 400 square miles in the southern end of Escalante Valley. Ground water occurs in unconsolidated deposits in the district, mostly under water-table conditions. Recharge to the aquifers come mainly from Pinto, Meadow Valley, and Shoal Creeks and other small streams which enter the district from the mountains to the south.

During 1965, six wells were constructed in the Beryl-Enterprise district, all being 6 inches or more in diameter. Three were new wells and three were replacement wells. Five wells were to be used for irrigation and one new well was for stock use.

The amount of water pumped from wells in 1965 was about 70,000 acre-feet, broken down as follows:

Irrigation	69,200
Domestic and stock	600
Public supply	100

Pumpage for irrigation was about 1,700 acre-feet less than that of 1964 (Arnow and others, 1965, p. 91). The decrease was probably due to differences in irrigation practices and in the amount of land irrigated. Some decrease may have resulted from increased precipitation, although precipitation falling directly on the land has little effect on pumping practices.

Water levels declined in the Beryl-Enterprise district from March 1965 to March 1966 except for a small area near Enterprise. (See fig. 47.) Water levels rose near Enterprise, probably because of recharge from increased runoff in Shoal Creek during the winter months. The decline was caused primarily by pumping. Although precipitation on the area was above normal, it mainly is consumed

by evapotranspiration and contributes little to recharge.

Figure 47 also shows the overall change in water levels from March 1959 to March 1966. Water levels declined least in the northern part of the district where there are a few pumped wells scattered over a large area. The decline becomes progressively larger toward the south where there are more pumped wells concentrated in a smaller area. Net declines from 1950 to 1966 have been as much as 45.4 feet. The greatest decline was in the southern part of the district, about 1 mile north of Enterprise (fig. 47). The long-term relation between water levels, precipitation, and pumpage is shown in figure 48. The water level in well (C-35-17) 25dcd-1 continued to decline at about the same rate as the decline during the previous 18 years in the heavily pumped part of the district. By October 1964, the continuous decline of water levels had resulted in a reversal in the direction of ground-water movement (Arnow and others, 1965, p. 91). Although water levels recovered somewhat from October 1964 to March 1965, the natural direction of movement (northward) was still reversed and ground water continued to flow southward. Water-level declines during 1965 aggravated this condition; and by October 1965, the depressed area of the water table northeast of Enterprise had greatly enlarged. (See fig. 49.) Figure 50 shows the water-level contours for March 1966, and the gradient toward the south is greater than it was in March 1965 (Arnow and others, 1965, p. 95). If the trend of the past 18 years persists, the gradient toward the south will increase and progressively larger amounts of water from the north will recharge the southern area.

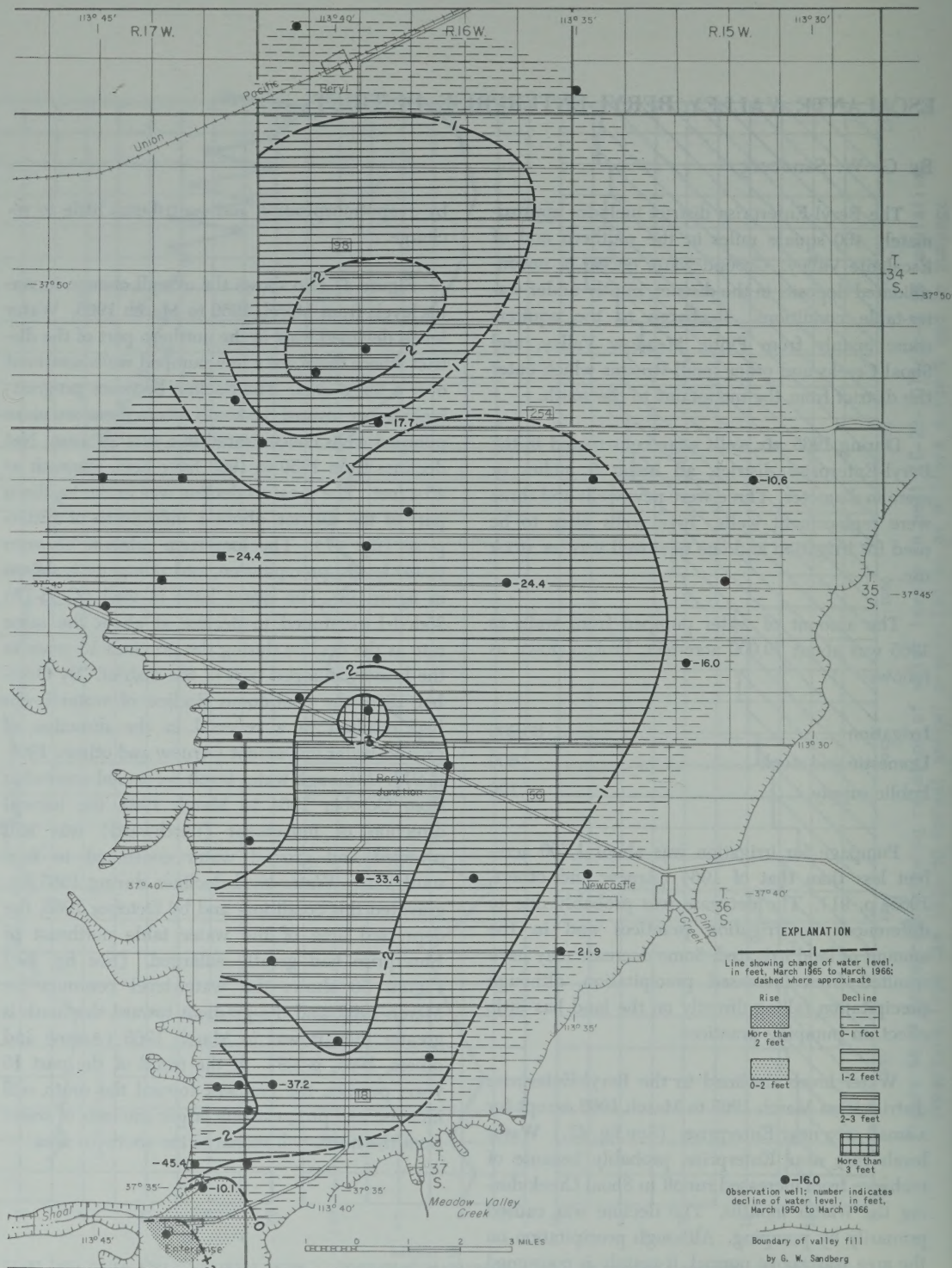


Figure 47.—Map of the Beryl-Enterprise district, Escalante Valley, showing change of water levels, March 1965 to March 1966.

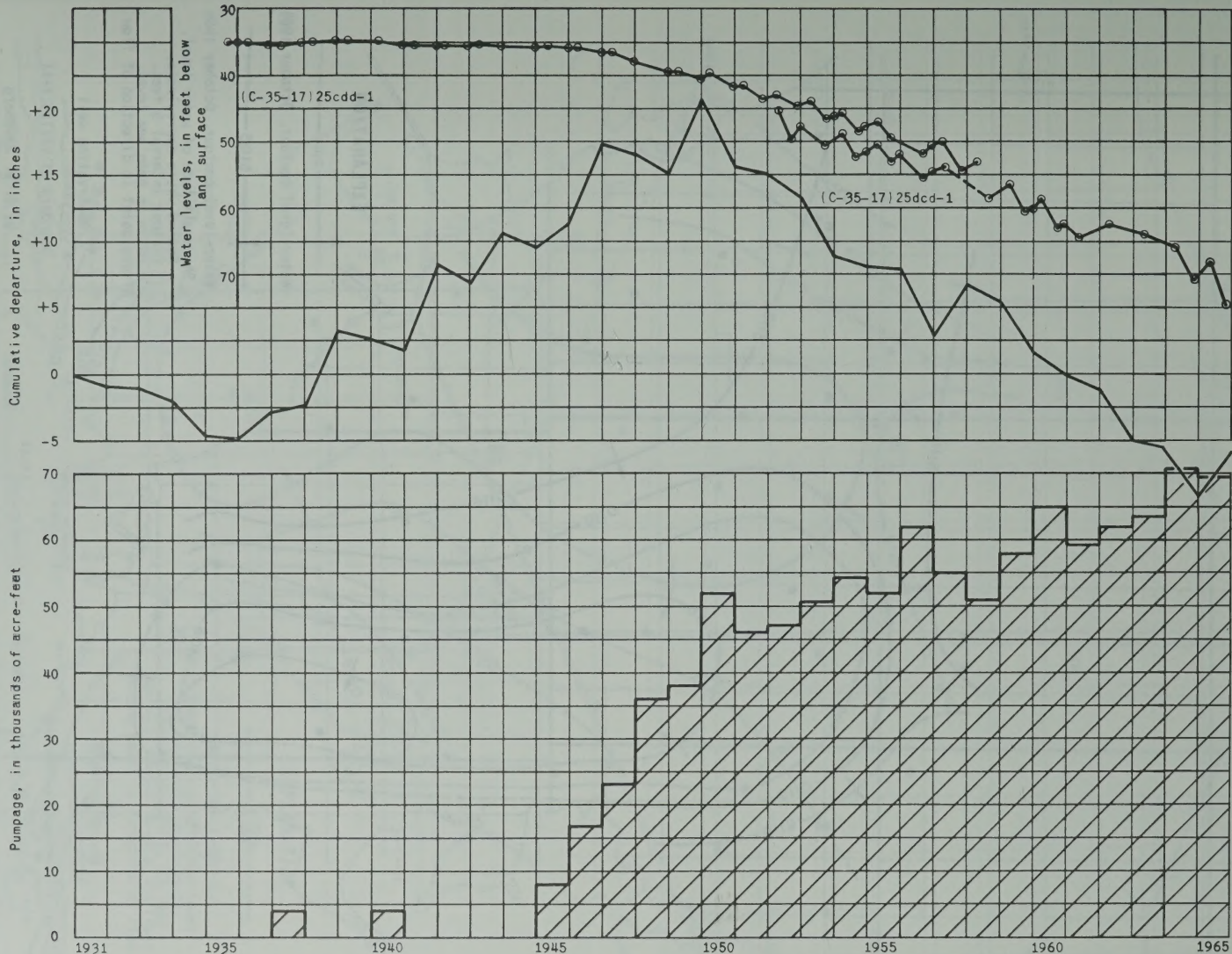


Figure 48.—Hydrographs showing relation of water levels in wells (C-35-17)25cdd-1 and (C-35-17)25dcd-1 to cumulative departure from the 1931-60 normal annual precipitation at Modena and to pumpage for irrigation in the Beryl-Enterprise district, Escalante Valley.

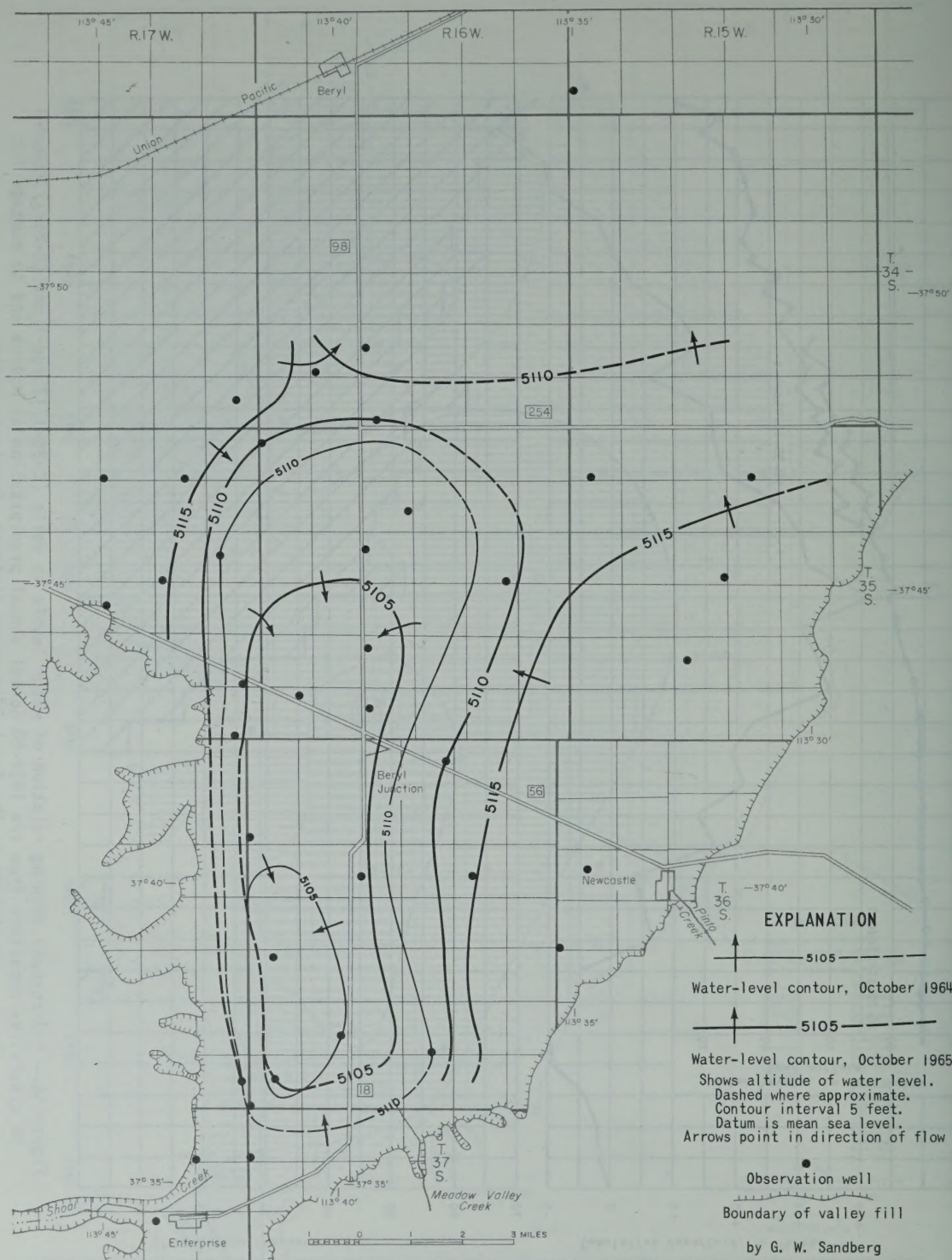


Figure 49.—Map of the Beryl-Enterprise district, Escalante Valley, showing water-level contours, October 1964 and October 1965.

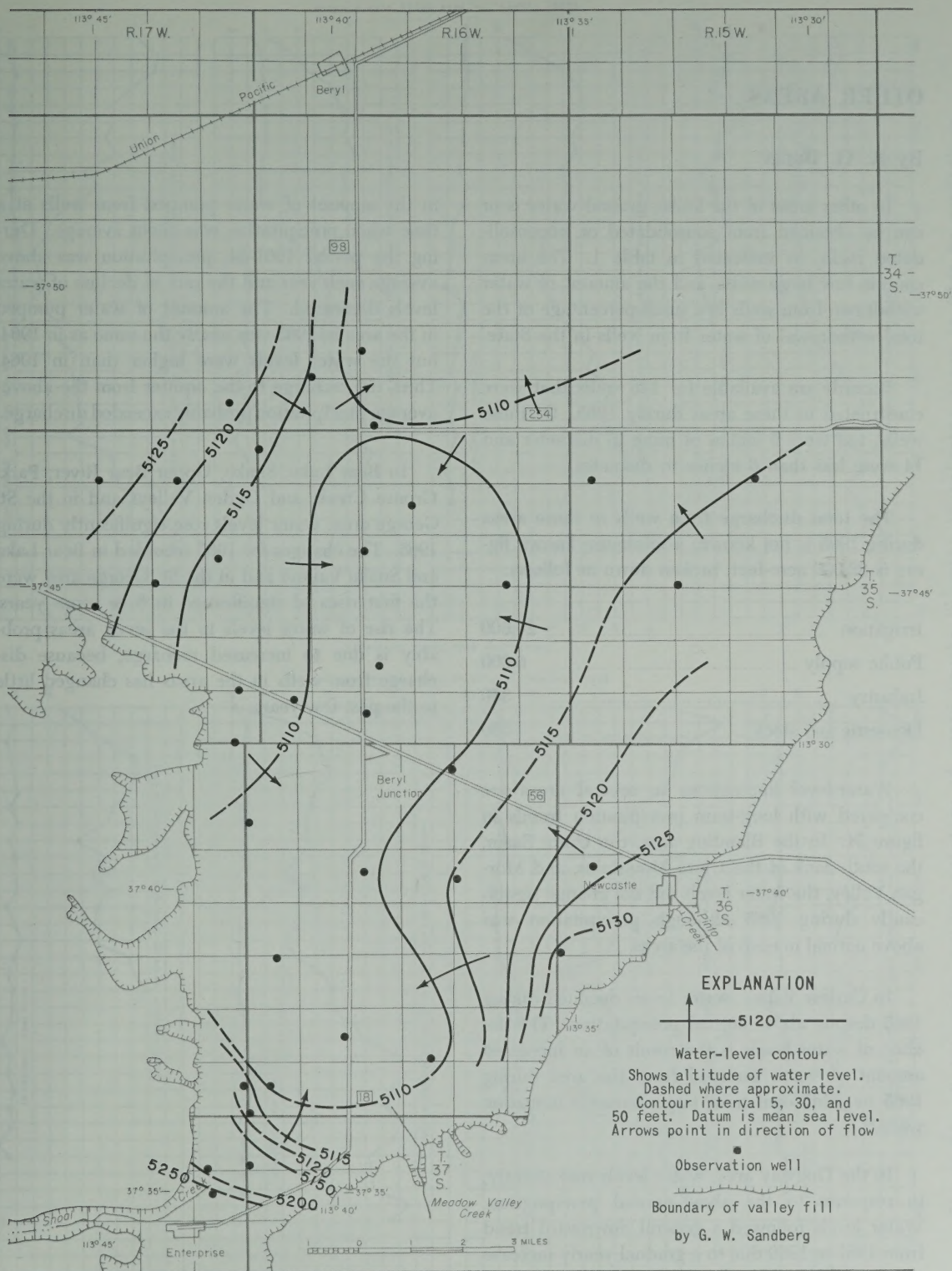


Figure 50.—Map of the Beryl-Enterprise district, Escalante Valley, showing water-level contours, March 1966.

OTHER AREAS

By R. G. Butler

In other areas of the State, ground water is or can be obtained from consolidated or unconsolidated rocks, as indicated in table 1. The areas contain few large wells, and the amount of water withdrawn from wells is a small percentage of the total withdrawal of water from wells in the State.

Records are available for 146 wells that were constructed in these areas during 1965. Of these wells, 132 were 6 inches or more in diameter and 14 were less than 6 inches in diameter.

The total discharge from wells in these areas during 1965 is not known; a minimum known figure is 32,000 acre-feet, broken down as follows:

Irrigation	24,600
Public supply	6,600
Industry	350
Domestic and stock	550

Water-level fluctuations in several areas are compared with long-term precipitation trends in figure 51. In the Blanding area, the Uinta Basin, the south flank of the Uinta Mountains, and Morgan Valley, the water levels did not change significantly during 1965 although precipitation was above normal in each of the areas.

In Curlew Valley, water levels declined during 1965 despite above-normal precipitation. The decline of water levels is the result of an increased amount of water pumped from the area during 1965 by additional new, large-diameter irrigation wells.

In the Dugway area, water levels rose slightly, in response to the above-normal precipitation. Water levels followed a general downward trend from 1951 to 1960 due to a gradual yearly increase

in the amount of water pumped from wells at a time when precipitation was about average. During the period 1961-64, precipitation was above average each year and the rate of decline of water levels decreased. The amount of water pumped in the area in 1965 was nearly the same as in 1964, but the water levels were higher than in 1964. Thus, the recharge to the aquifer from the above-average precipitation probably exceeded discharge.

In Bear Lake, Snake, Upper Bear River, Park, Grouse Creek, and Ogden Valleys and in the St. George area, water levels rose significantly during 1965. The changes for 1965 recorded in Bear Lake and Snake Valleys and in the St. George area were the first rises of significance in 6 or more years. The rise of water levels in the seven areas probably is due to increased recharge, because discharge from wells in the areas has changed little in the past few years.

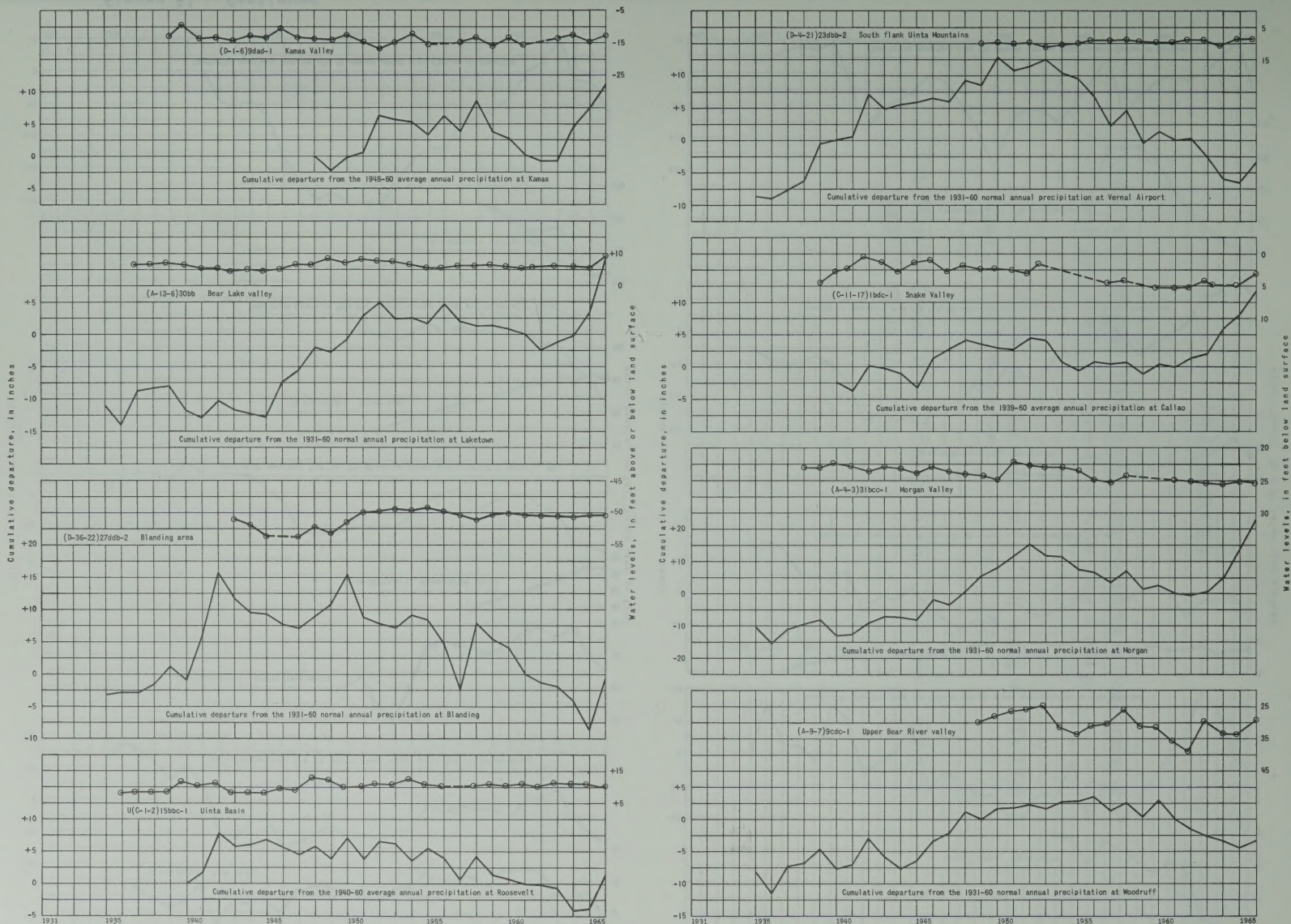


Figure 51.—Hydrographs showing relation of water levels in wells in selected areas in Utah to cumulative departure from average annual precipitation at sites in or near those areas.

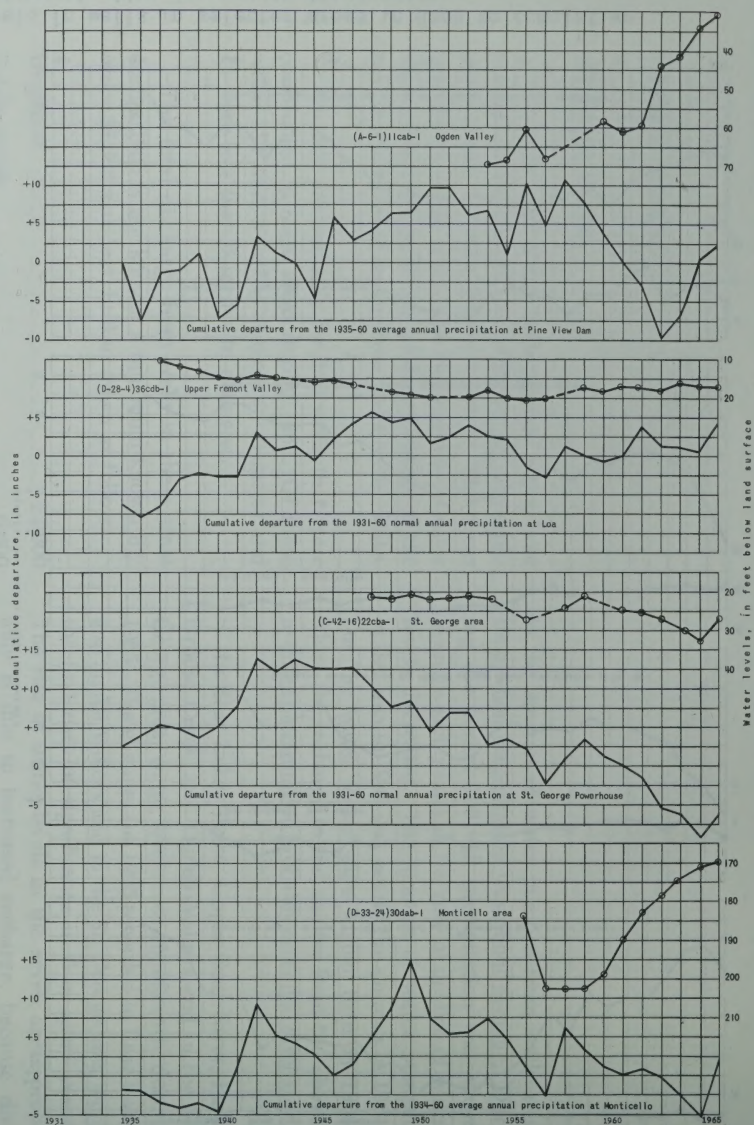
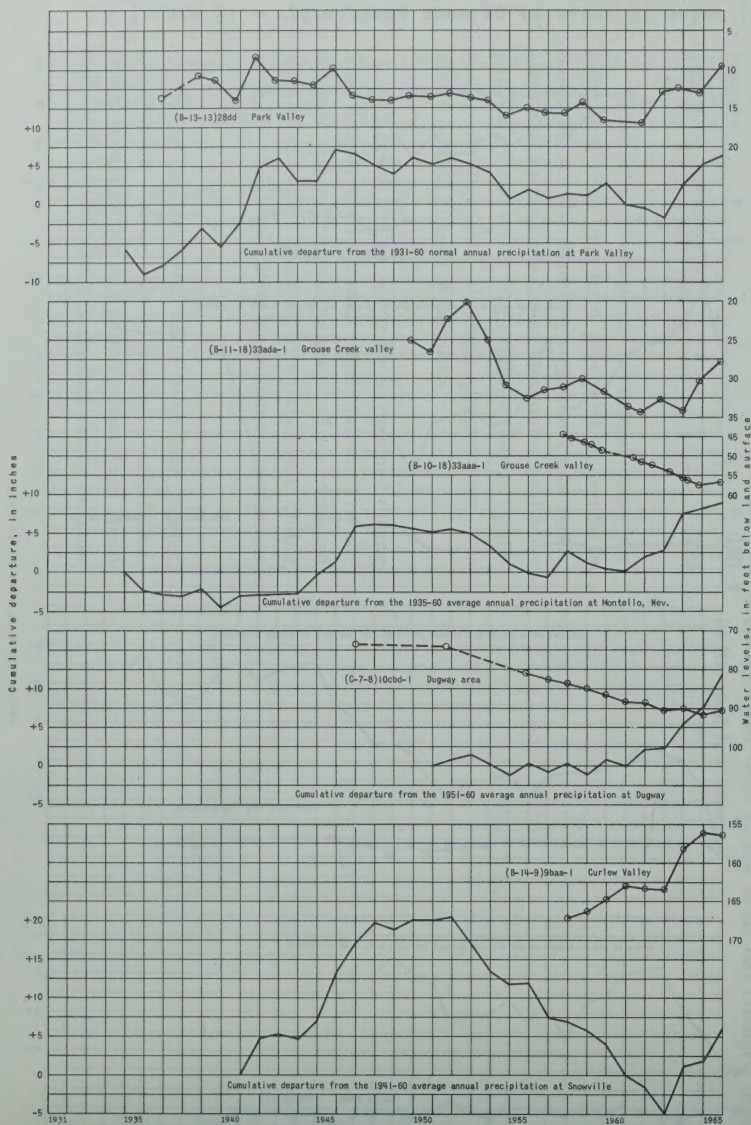


Figure 51.—Continued.

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